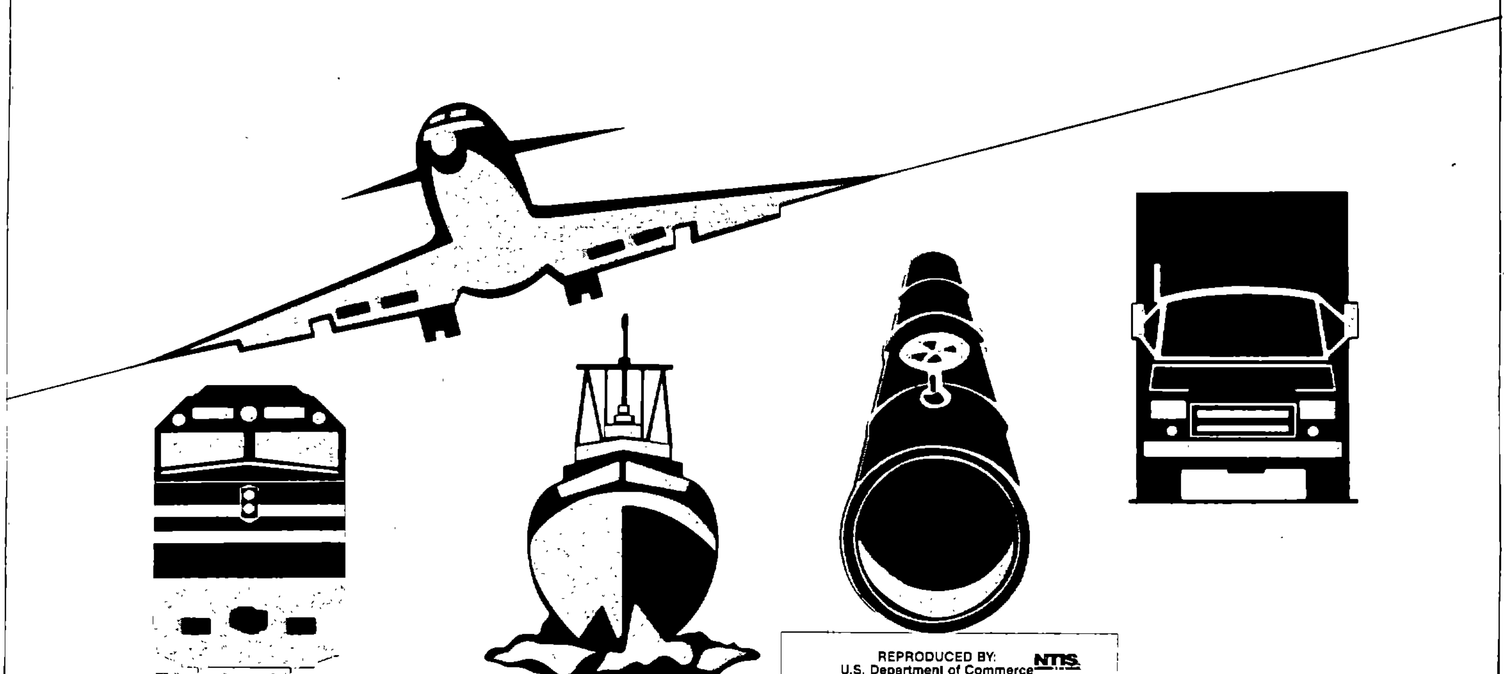
PB98-916609
NTSB/REC-98/09

NATIONAL TRANSPORTATION SAFETY BOARD

TRANSPORTATION SAFETY RECOMMENDATIONS

ADOPTED DURING THE MONTH OF SEPTEMBER, 1998



TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/REC-98/09	2. Government Accession No. PB98-916609	3. Recipient's Catalog No.
4. Title and Subtitle Transportation Safety Recommendations - Adopted during the month of September, 1998.		5. Report Date
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Office of Safety Recommendations Washington, D.C. 20594		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This publication contains safety recommendations in aviation, highway, pipeline and railroad modes of transportation adopted by the National Transportation Safety Board during the month of September, 1998.

AVIATION

A-98-84 through 86
A-98-109 through 110

HIGHWAY

H-98-41
H-98-42

PIPELINE

P-98-21 through 23
P-98-24

RAILROAD

R-98-48 through 53
R-98-54 through 57
R-98-58 through 61
R-98-62
R-98-63
R-98-64
R-98-65
R-98-66

17. Key Words		18. Distribution Statement	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 73	22. Price

NTSB Form 1765.2 (Rev. 9/74)

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 8, 1998
In reply refer to: A-98-84 through -86

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On January 12, 1997, about 1026 Hawaiian standard time, a McDonnell Douglas Helicopter Systems (MDHS)[1] 369D helicopter, N7012G, powered by one Allison 250-C20B turboshaft engine, lost engine power about 150 feet above ground level (agl) shortly after takeoff from a helipad near Kamuela, Hawaii. The pilot initiated an autorotation, but the helicopter landed hard in an open field, resulting in the main rotor blades severing the tailboom. The helicopter was substantially damaged; however, the pilot was not injured. No flight plan was filed, and visual meteorological conditions prevailed at the time of the accident. The flight was operated under Title 14 Code of Federal Regulations Part 91 as a personal flight.

The MDHS 369 series (formerly Hughes 369 series) has one two-cell fuel tank. The airframe fuel system has a fuel tank boost pump to provide positive-pressure fuel delivery to the engine for starting. The engine-driven fuel pump provides high-pressure fuel to the fuel control unit (FCU), which meters fuel to the fuel nozzle. The fuel nozzle is a two-stage single-barrel fuel delivery device providing fuel to the engine for starting and fuel spray for continuous operation. The Allison 250 series engine has three fuel straining devices to prevent contaminants in the fuel from reaching the engine. The fuel pump has a two-stage filter with a bypass and pressure sensor to activate a warning light in the cockpit if the fuel flow through the filter is obstructed (impending bypass). The FCU has an inlet fuel screen with a bypass feature with no associated warning indication. The fuel nozzle has a fuel screen with neither a bypass feature nor an associated warning indicator.

During the investigation of the Kamuela, Hawaii, accident, Safety Board investigators found that the fuel nozzle screen was contaminated with foreign material, including sodium chloride (salt). Contamination was also found in the fuel pump filter and FCU screen of the engine fuel system.

[1] The MDHS commercial helicopter division was recently acquired by Boeing Aircraft Company.

The maintenance records indicated that the helicopter had been inspected in accordance with the manufacturer's recommended 100/300-hour inspection procedures about 21 flight hours before the accident. The inspection procedures did not include inspecting the fuel nozzle screen nor the FCU screen, but did include replacement of the engine fuel pump filter. The engine manufacturer's inspection guidelines recommend that the fuel nozzle screen be inspected only when the engine fuel filter bypass light illuminates and/or the engine fuel pump filter is found to be contaminated. The maintenance records did not indicate a contaminated fuel filter during the 100/300-hour inspection nor had there been any reports of an illuminated fuel filter bypass light. The fuel nozzle has an overhaul time limit of 2,500 flight hours with no requirement for regularly scheduled interim inspections. The accident nozzle had accumulated about 317 flight hours since overhaul. The engine had been operated in a salt water environment, and its maintenance records showed that it had been subject to regular wash procedures (see enclosed Brief of Accident File No. 654).

The Safety Board is aware of three similar accidents involving fuel nozzle screen contamination of Allison 250 series engines. On November 16, 1996, near Forks, Washington, a Hughes 369D helicopter, registration N5225C, lost engine power during an external load operation. The helicopter received substantial damage when it collided with trees during its autorotational descent. The investigation revealed contamination throughout the helicopter's fuel system. The fuel filters were contaminated and in the bypass mode, and the fuel nozzle screen was found partially blocked by contaminants. The fuel contaminants were traced to the operator's in-ground storage tanks (see enclosed Brief of Accident File No. 1569).

On April 14, 1996, near Yerington, Nevada, a Hughes 369D helicopter, registration N519BH, lost engine power during cruise flight at 200 to 300 feet agl. The subsequent engine-out emergency landing resulted in substantial damage to the helicopter. The helicopter had an annual inspection 6 months before the accident. The last compressor wash was 2 months before the flight, and the helicopter had been flown 8 hours since the compressor wash. Examination of the FCU inlet screen and the fuel pump fuel filter did not reveal contaminants; however, the engine flamed out during the initial postaccident engine test run and experienced consistent engine power degradation in all tests. Inspection of the engine fuel nozzle after the test runs revealed a partially blocked screen (see enclosed Brief of Accident No. 689).

On April 18, 1994, a Hughes 369D helicopter, registration N1103N, lost engine power during a sightseeing flight near Hanapepe, Hawaii. While maneuvering, the engine suddenly lost power, and, after an autorotation, the helicopter landed hard on rocky terrain. Examination of the engine fuel system revealed that the fuel nozzle screen was obstructed by contaminants, including salt. The helicopter was operated in a marine environment with substantial operations over the ocean. The maintenance procedures used by the company included daily engine compressor rinses (see enclosed Brief of Accident No. 1416).

In addition to the above-mentioned accidents, investigators found a Federal Aviation Administration (FAA) maintenance periodical, Advisory Circular No. 43.16, titled "General

Aviation Airworthiness Alerts," which described an incident that involved an Allison 250-C20 engine installed in a Hughes 369D helicopter. During flight, the engine reportedly lost power without warning; however, the pilot performed a successful autorotational landing. The investigation revealed a severely restricted fuel nozzle screen. The fuel nozzle's historical flight hours and the contaminants blocking the screen were not reported.

The Safety Board's staff also found that numerous malfunction or defect reports of partially clogged Allison 250 engine fuel nozzles have been submitted by mechanics. These fuel nozzles are not removed based on a schedule provided by the manufacturer, but based on deteriorating engine performance or the mechanic's personal experience. Because these measures have not proved adequate, corrective action is needed to address the engine power losses that have been caused by contamination of Allison 250 series fuel nozzle screens. The Safety Board believes that the FAA should direct all operators of helicopters powered by Allison 250 series engines to conduct a one-time inspection of all the engine fuel nozzle screens to ensure that they are intact, unobstructed, and functional. After the one-time inspection, the Safety Board believes that the FAA should determine appropriate inspection intervals for helicopters powered by Allison 250 series turboshaft engines and then require that periodic inspections be accomplished on those engine fuel nozzle screens to prevent the accumulation of contaminants that could alter the fuel delivery, engine performance, and ultimately clog the fuel nozzle screen and cause engine power loss.

The Safety Board notes that of those occurrences known to the Board, all of the MDHS 369 helicopters involved in fuel nozzle screen anomalies have not had an airframe-mounted fuel filter installed, which is optional on MDHS 369 series and some other makes of helicopters. Although the airframe-mounted fuel filter does not capture smaller particles than the fuel pump filter, the airframe-mounted filter does afford greater surface area filtration. Also, the fuel nozzles installed on Allison 250 series engines do not have a fail-safe design (bypass feature), even though a failure or obstruction of the nozzle results in complete loss of engine power. Therefore, the Safety Board believes that the FAA should determine if the optional airframe-mounted fuel filter on helicopters powered by Allison 250 series engines provides substantial improvement in the removal of fuel system contaminants, and, if so, require airframe-mounted fuel filters on those helicopters that do not already have them installed.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Direct all operators of helicopters powered by Allison 250 series engines to conduct a one-time inspection of all the engine fuel nozzle screens to ensure that they are intact, unobstructed, and functional. (A-98-84)
>
> Determine appropriate inspection intervals for helicopters powered by Allison 250 series turboshaft engines and then require that periodic inspections be accomplished on those engine fuel nozzle screens to prevent the accumulation of contaminants that could alter the fuel

delivery, engine performance, and ultimately clog the fuel nozzle screen and cause engine power loss. (A-98-85)

Determine if the optional airframe-mounted fuel filter on helicopters powered by Allison 250 series engines provides substantial improvement in the removal of fuel system contaminants, and, if so, require airframe-mounted fuel filters on those helicopters that do not already have them installed. (A-98-86)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Jim Hall

By: Jim Hall
Chairman

Enclosures

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 02/02/1998

LAX97LA088
FILE NO. 654 01/12/97 KAMUELA,HI AIRCRAFT REG. NO. N7012G TIME (LOCAL) - 10:26 HST

MAKE/MODEL - McDonnell Douglas 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	1
PASS	0	0	0

OPERATING CERTIFICATES - On-demand air taxi
- Rotorcraft-external load operator

TYPE OF FLIGHT OPERATION - Positioning
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0010.000 SM
WIND DIR/SPEED - 340 /008 KTS
TEMPERATURE (F) - 77
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 37

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
Helicopter

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 9400
LAST 90 DAYS - Unk/Nr
TOTAL MAKE/MODEL - Unk/Nr
TOTAL INSTRUMENT TIME - Unk/Nr

The helicopter was being operated in a marine environment. The pilot reported he lost engine power during the initial takeoff climb and autorotated to an open field. The helicopter landed hard and the main rotor blades severed the tailboom. Examination of the engine fuel filter, the fuel control unit (FCU) screen, and the fuel nozzle screen revealed contamination in the fuel system. The helicopter had been inspected in accordance with the manufacturer's 100/300 hour inspection about 21.2 flight hours before the accident. There were no reports of the engine fuel filter bypassing or the fuel filter caution light illuminating. The manufacturer's inspection program does not require the inspection of the fuel screens at the 100 or 300 hour intervals. The airframe manufacturer's maintenance manual does indicate that a conditional inspection be performed after the fuel filter caution light has illuminated. Review of the conditional inspection procedures revealed the FCU screen is to be removed and cleaned; however, there is no requirement for the removal and cleaning of the nozzle screen, which is downstream of the FCU screen, before the part's 2,500 hour overhaul cycle.

LAX97LA088
FILE NO. 654 | 01/12/97 | KAMUELA,HI | AIRCRAFT REG. NO. N7012G | TIME (LOCAL) - 10:26 HST

Occurrence# 1 LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation TAKEOFF - INITIAL CLIMB

Findings
1. - FUEL SYSTEM - CONTAMINATION
2. - FUEL SYSTEM,NOZZLE - BLOCKED(PARTIAL)
3. - PROCEDURE INADEQUATE - MANUFACTURER
4. - INSUFFICIENT STANDARDS/RQRMNTS,MANUFACTURER - MANUFACTURER
5. - FLUID,FUEL - OBSTRUCTED
6. - TURBOSHAFT ENGINE - OUTPUT LOW

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY LANDING AFTER TAKEOFF

Occurrence# 3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
7. - TERRAIN CONDITION - GROUND
8. - AUTOROTATION - IMPROPER - PILOT-IN-COMMAND
9. - ROTOR RPM - NOT MAINTAINED - PILOT-IN-COMMAND

The National Transportation Safety Board determines that the probable cause(s) of this accident was: fuel system contamination resulting in a partial loss of power, and the failure of the pilot to maintain adequate rotor rpm to cushion the autorotative landing and prevent main rotor blade contact with the tailboom. Factors were the inadequacy of manufacturer's maintenance inspection procedures for aircraft operated in a marine environment.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 08/21/1997

SEA97LA032
FILE NO. 1569 11/16/96 FORKS,WA AIRCRAFT REG. NO. N5225C TIME (LOCAL) - 15:00 PST

MAKE/MODEL - Hughes 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	1	0
PASS	0	0	0

OPERATING CERTIFICATES - Rotorcraft-external load operator
TYPE OF FLIGHT OPERATION - Other work use
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 133

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Pilot

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - 2000 FT Broken
VISIBILITY - 0003.000 SM
WIND DIR/SPEED - 225 /005 KTS
TEMPERATURE (F) - 40
OBSTR TO VISION - None
PRECIPITATION - Unk/Nr

PILOT-IN-COMMAND AGE - 50

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
Helicopter

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 18610
LAST 90 DAYS - Unk/Nr
TOTAL MAKE/MODEL - 5825
TOTAL INSTRUMENT TIME - Unk/Nr

The helicopter lost engine power during an external load/logging operation, then it sustained substantial damage when it collided with trees during an emergency landing. Investigation revealed that fuel contamination disrupted the flow of fuel from the engine fuel nozzle(s). Test samples from the fuel supplier, storage tank, and the helicopter's fuel filter were provided by the operator to an independent laboratory. Testing showed that the fuel supplier's sample was free of contamination, but contamination was found in samples from the storage tank and the helicopter fuel filter.

SEA97LA032
FILE NO. 1569 | 11/16/96 | FORKS,WA | AIRCRAFT REG. NO. N5225C | TIME (LOCAL) - 15:00 PST

Occurrence# 1 LOSS OF ENGINE POWER(TOTAL) - NON-MECHANICAL
Phase of Operation MANEUVERING

Findings
1. - FLUID,FUEL - CONTAMINATION,OTHER THAN WATER
2. - MAINTENANCE,SERVICE OF AIRCRAFT - IMPROPER

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY DESCENT/LANDING

Findings
3. - AUTOROTATION - PERFORMED - PILOT-IN-COMMAND

Occurrence# 3 IN-FLIGHT COLLISION WITH OBJECT
Phase of Operation EMERGENCY LANDING

Findings
4. - TERRAIN CONDITION - NONE SUITABLE
5. - OBJECT - TREE(S)

The National Transportation Safety Board determines that the probable cause(s) of this accident was: fuel contamination, which resulted in loss of engine power. Factors relating to the accident included: improper servicing of the helicopter, and a lack of suitable terrain for an emergency landing due to the proximity of trees.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 12/16/1996

LAX96LA168
FILE NO. 689 04/14/96 YERINGTON,NV AIRCRAFT REG. NO. N519BH TIME (LOCAL) - 11:55 PDT

MAKE/MODEL - Hughes 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	1
PASS	0	0	2

OPERATING CERTIFICATES - None
TYPE OF FLIGHT OPERATION - Personal
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Pilot

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0050.000 SM
WIND DIR/SPEED - 315 /005 KTS
TEMPERATURE (F) - 70
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 68

CERTIFICATES/RATINGS
Private
Single-engine land, Multiengine land
Helicopter, Free balloon, Glider
INSTRUMENT RATINGS
None

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 6348
LAST 90 DAYS - 8
TOTAL MAKE/MODEL - 176
TOTAL INSTRUMENT TIME - Unk/Nr

The pilot experienced a total loss of engine power while cruising between 200 and 300 feet above ground level and at an airspeed of 100 knots. The pilot reported that the engine noise resembled the same whining as if it were in a shut down mode. The pilot entered an autorotation and landed in an open field approximately 0.5 miles from his airstrip. The accident site examination revealed that the helicopter had touched down with forward speed and made depressions in the soft ground over a distance of 25 to 30 feet. The helicopter rolled onto its side and a main rotor blade severed the tail boom. Tail rotor blade and drive shaft components separated from the helicopter and were found 200 feet from the main wreckage. The last annual inspection was performed 6 months prior to the accident flight and the aircraft had flown 16.9 hours. Also, the last compressor wash was performed about 2 months prior to the flight and had flown 8 hours since then. The postaccident engine examination revealed accumulated nozzle port debris and dirty compressor blades and vanes. The engine flamed out during its first test run and, during subsequent tests, it produced power 7.8 percent below specifications.

LAX96LA168
FILE NO. 689 04/14/96 YERINGTON,NV AIRCRAFT REG. NO. N519BH TIME (LOCAL) - 11:55 PDT

Occurrence# 1 LOSS OF ENGINE POWER(PARTIAL) - NON-MECHANICAL
Phase of Operation CRUISE - NORMAL

Findings
1. - FUEL SYSTEM,NOZZLE - CONTAMINATION
2. - COMPRESSOR ASSEMBLY,BLADE - DIRTY(FOGGY)

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY DESCENT/LANDING

Findings
3. - AUTOROTATION - PERFORMED - PILOT-IN-COMMAND

Occurrence# 3 ROLL OVER
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
4. - FLARE - MISJUDGED - PILOT-IN-COMMAND
5. - TERRAIN CONDITION - OPEN FIELD
6. - TERRAIN CONDITION - SOFT

The National Transportation Safety Board determines that the probable cause(s) of this accident was:
the partial loss of engine power and the pilot's misjudged flare during an autorotation landing in soft dirt with excessive forward speed. The power loss resulted from flight operations in an environment which debris contaminated the engine's nozzle port and compressor assembly.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 04/07/1995

LAX94FA197
FILE NO. 1416 04/18/94 HANAPEPE,HI AIRCRAFT REG. NO. N1103N TIME (LOCAL) - 13:14 HST

MAKE/MODEL - HUGHES 369D
ENGINE MAKE/MODEL - ALLISON 250-C20B
AIRCRAFT DAMAGE - Destroyed
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	1	0
PASS	1	3	0

OPERATING CERTIFICATES - On-demand air taxi
- Rotorcraft-external load operator

TYPE OF FLIGHT OPERATION - SIGHTSEEING
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0015.000 SM
WIND DIR/SPEED - 040 /018 KTS
TEMPERATURE (F) - 77
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 32

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
None

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 3100
LAST 90 DAYS - 40
TOTAL MAKE/MODEL - 2200
TOTAL INSTRUMENT TIME - 110

THE PILOT REPORTED THAT WHILE MANEUVERING NEAR A WATERFALL ON A SIGHT-SEEING FLIGHT, THE HUGHES 369D SUSTAINED A LOSS OF ENGINE POWER, DESCENDED, AND LANDED HARD ON ROUGH/ROCKY TERRAIN. AN EXAM OF THE ENGINE REVEALED THE FUEL NOZZLE STRAINER WAS CONTAMINATED AND BLOCKED WITH SODIUM, AND IT WAS PARTIALLY COLLAPSED. TESTS OF THE NOZZLE REVEALED THAT FLOW RATES WERE BELOW THE MANUFACTURER'S SPECIFICATIONS. THE HELICOPTER WAS BEING OPERATED EXCLUSIVELY IN A MARINE ENVIRONMENT AND THE OPERATOR PERFORMED COMPRESSOR WASH PROCEDURES ON A DAILY BASIS. IN A SERVICE LETTER, THE ENGINE MANUFACTURER PRESCRIBED TURBINE ENGINE COMPRESSOR WASH PROCEDURES WHICH RESULTED IN IMMERSION OF THE FUEL NOZZLE IN CONTAMINATED WASH WATER. THERE WAS EVIDENCE OF SUBSEQUENT INFILTRATION OF WASH WATER INTO THE FUEL NOZZLE STRAINER. THE FUEL NOZZLE STRAINER HAD A LIFE LIMIT OF 2500 HOURS, BUT ACCORDING TO THE MANUFACTURER, IT WAS NOT SUBJECT TO ANY PRIOR ROUTINE INSPECTION REQUIREMENT.

LAX94FA197
FILE NO. 1416 04/18/94 HANAPEPE,HI AIRCRAFT REG. NO. N1103N TIME (LOCAL) - 13:14 HST

Occurrence# 1 LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation HOVER

Findings
1. - FUEL SYSTEM,NOZZLE - FOREIGN MATERIAL/SUBSTANCE
2. - FUEL SYSTEM,STRAINER - BLOCKED(PARTIAL)
3. - MAINTENANCE,SERVICE BULLETINS - INADEQUATE - MANUFACTURER
4. - PROCEDURE INADEQUATE - MANUFACTURER
5. - INSUFFICIENT STANDARDS/REQUIREMENTS - MANUFACTURER

Occurrence# 2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Occurrence# 3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
6. - TERRAIN CONDITION - ROUGH/UNEVEN

The National Transportation Safety Board determines that the probable cause(s) of this accident was:
INADEQUATE TURBINE ENGINE COMPRESSOR CLEANING PROCEDURES BASED ON INFORMATION IN THE MANUFACTURER'S SERVICE LETTER, AND LOSS OF ENGINE POWER DUE TO BLOCKAGE OF THE FUEL NOZZLE STRAINER WITH FOREIGN MATERIAL (SODIUM). FACTORS RELATED TO THE ACCIDENT WERE: THE LACK OF A SPECIFIED SERVICE REQUIRMENT FOR INSPECTION OF THE FUEL STRAINER, AND TERRAIN CONDITIONS IN THE EMERGENCY LANDING AREA.

National Transportation Safety Board

Washington D.C. 20594

Safety Recommendation

Date: September 14, 1998
In reply refer to: A-98-109 through -110

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On October 15, 1997, about 1030 mountain daylight time, a Cessna P210N, N731NX, operated by the Sheriff's Department of Mesa County, Colorado, experienced an in-flight electrical fire while cruising at 16,500 feet over Bryce Canyon, Utah. The commercial pilot initiated an emergency descent and landed uneventfully in Bryce Canyon with minor damage. The pilot and his passenger were not injured. Visual meteorological conditions prevailed, and a visual flight rules flight plan had been filed. The public-use flight was conducted under Title 14 Code of Federal Regulations Part 91, and originated from Grand Junction, Colorado, about 60 minutes before the incident.

The Safety Board's investigation revealed that the fire originated on the cabin sidewall, under the left side of the instrument panel, and resulted in burned vinyl, plastic, and insulation material.[1] The fire was caused by an overheated resistor used in an electric door seal inflation system. The resistor was used to reduce the 28-volt aircraft electrical system's voltage to meet the power requirements of the door seal system's 14-volt air pump motor. The system had been installed on the airplane in accordance with a Federal Aviation Administration (FAA)-approved supplemental type certificate (STC)[2] that was issued to the system's manufacturer, Bob Fields Aerocessories, Inc., in 1983. The purpose of the system is to decrease in-flight cabin

[1] Bryce Canyon, Utah, October 15, 1997, Cessna P210N, N731NX (FTW98TA051).

[2] A supplemental type certificate can be issued by the FAA for design changes to type-certificated aircraft when the change is not so extensive as to require a new type certificate for that aircraft. STCs are typically approved for optional after-market kits that improve an aircraft design. The STC applicant must submit sufficient technical data to the FAA to show compliance with the applicable certification requirements.

noise caused by ill-fitting cabin doors. According to Bob Fields Aerocessories, about 20,000 of these systems are currently installed in a wide variety of single- and twin-engine general aviation airplanes.

Since the Bryce Canyon incident in October 1997, the Safety Board has investigated one accident and two incidents that also involved in-flight fires originating in electric inflatable door seal systems manufactured by Bob Fields Aerocessories. Moreover, a review of the FAA's Service Difficulty Report database revealed four additional reports of overheated components associated with the door seal system, three of which cited smoke in the cockpit. A description of the recent accident and incidents investigated by the Safety Board follows.

On November 20, 1997, a Beech 95-B55, N3681K, sustained substantial damage after impacting trees during a precautionary landing in Burlington, Kansas. The landing was precipitated by smoke and an electrical fire in the cabin during cruise flight at 6,500 feet. Postaccident examination of the airplane revealed that a Bob Fields Aerocessories electric door seal inflation pump, mounted on the forward side of the nose bulkhead, was heavily charred. The Safety Board determined that the probable cause of the accident was, in part, "the door seal inflation pump catching fire."[3]

On June 25, 1998, the pilot of a Cessna P210N, N5083W, initiated a precautionary landing in Ithaca, New York, after heavy smoke had entered the cabin during cruise flight at 5,000 feet. Immediately after the landing, airport fire and rescue personnel discovered a self-sustaining fire originating under the left side of the instrument panel. Vinyl, plastic, and insulation material had burned in the fire. Subsequent examination of the airplane revealed that one of the resistors used in the Bob Fields Aerocessories electric door seal inflation system installed on the airplane was partially melted.[4] The Safety Board recently learned of a July 17, 1998, incident aboard a Beech 58 airplane in which the pilot reported a burning smell in the cockpit while in cruise flight. He landed in Toms River, New Jersey, and asked a mechanic to inspect the airplane. The mechanic reported that the pump assembly and resistors for the installed Bob Fields Aerocessories electric door seal inflation system, mounted in the nose compartment, were partially melted.[5]

The electric door seal inflation system manufactured by Bob Fields Aerocessories consists of an electric motor, an air pump, inflatable silicon door seals, a pressure sensing switch, an air supply control valve, a resistor assembly, a 7.5-amperes (amps) in-line fuse, a caution light, and electrical wiring. A 5-amp circuit breaker may also be provided as an option. The motor draws power directly from the airplane's battery bus and is used to inflate the door seals to a pressure of about 10 pounds per

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[3] For more detailed information, see Brief of Accident CHI98LA041 (enclosed).
[4] Ithaca, New York, June 25, 1998, Cessna P210N, N5083W (NYC98SA138).
[5] Toms River, New Jersey, July 17, 1998, Beech 58, N53RD (NYC98SA167).

square inch (psi). A sensor on the air pump determines when the pressure drops below 10 psi, at which time the air pump motor cycles back on until the proper pressure is achieved. According to the STC-holder, it takes between 4 and 12 seconds after system activation for the air pump to inflate the door seal; during this time, the caution light remains illuminated. If the door seal has a small leak, the pump cycles on and off to maintain the desired inflation pressure. If the door seal has a larger leak, the air pump may run continuously to keep the door seal inflated.

The Safety Board's review of the system design revealed that the system incorporates two identical 1-ohm resistors, each rated for a maximum of 50 watts. The resistors are wired close together and in series. According to technical specifications provided by the vendor of the resistor, the resistor's wattage capability should be derated to no more than 20 watts if it is not mounted onto a sufficiently sized conductive structure for heat dissipation. Test data from the vendor further indicate that the aluminum housing of a single resistor will heat up to 313° F when the resistor carries the nominal wattage of the door seal inflation system and is adequately mounted to provide for heat dissipation.[6] The housing temperature rises to more than 600° F if the resistor is not mounted to conductive material for heat dissipation. The potential for overheating is increased by the two resistors being wired closely together.

The Safety Board reviewed the FAA-approved installation instructions for the Bob Fields Aerocessories electric inflatable door seal pump. The instructions state, "...be sure to mount the resistors pak [sic] to a metal plate to make a heat sink. This plate and resistors can be mounted at the parking brake support angle under the instrument panel." No other instructions are found related to the resistor mounting. The investigations into the Bryce Canyon, Ithaca, and Toms River incidents revealed that the resistors were either hanging freely, or were mounted to structure in a manner that was insufficient to dissipate the heat generated by the resistors. The Safety Board is concerned that the installation instructions are insufficient and do not provide enough detail or cautions regarding the proper installation of the resistors and the minimum specifications for a heat sink.

The Safety Board is also concerned about other aspects of the design of the door seal inflation system that can lead to the overheating of the resistors and other system components. The design calls for the system to be installed in confined areas on the aircraft. For example, in the two-door Cessna airplane models, the STC suggests that the system be mounted behind the pilot's "kick panel." The kick panel area is a confined space between the external skin of the airplane just forward of the door and an upholstered panel under the left side of the pilot's instrument panel. This space has limited ventilation and inhibits the cooling required for a continuously

[6] The door seal inflation system draws a nominal current of 6 amps, thereby producing 36 watts of power through each 1-ohm resistor. Test data indicate that 36 watts of applied power through the specified resistor that is mounted on top of a box-shaped, aluminum chassis for heat conduction (0.040 inch thick, 5 inches wide, 7 inches long, and 2 inches deep) will produce a housing temperature of 313° F.

operating electrical pump and its associated resistors. The space also provides potentially combustible materials in close proximity to heated electrical components, as illustrated by the Bryce Canyon and Ithaca incidents.

Another aspect of the door seal inflation system design that could lead to overheating involves the endurance rating of the electrically driven air pump. According to the vendor that supplies the air pump to Bob Fields Aerocessories, the pump was originally designed to be plugged into an automotive cigarette lighter socket and was intended to be used for the emergency inflation of automobile tires. In a letter forwarded to the Safety Board, the vendor stated that the continuous use of the pump "should not exceed 10 minutes without stopping for 30 minutes" to prevent overheating. The application of the air pump for the pressurization of airplane door seals during flight is inappropriate because the pump may be required to operate for more than 10 minutes, or to run continuously if the door seal leaks. This was illustrated in the Bryce Canyon incident when the caution light was observed by the pilot to be continuously illuminated. The Safety Board is concerned that extended or continuous operation of the air pump will lead to excessive heat buildup, causing an excessive current draw, and will exacerbate the potential for overheating that already exists under the nominal current draw.

Examination of the in-line fuses for the Bryce Canyon, Ithaca, and Toms River incidents revealed that a fuse rated for 10 amps had been installed in the door seal inflation system, exceeding the 7.5-amp-rated fuse specified by the approved STC installation instructions. The Safety Board notes that excessive current draw may result in frequent blown fuses and may prompt the improper installation of a higher-rated fuse. Although the improper use of a 10-amp-rated fuse increases the potential for overheating components, the use of the specified 7.5-amp-rated fuse would not eliminate the hazard because, as discussed above, testing has shown that overheating of the resistors can occur at the nominal door seal inflation system current of 6 amps.

The Safety Board is also concerned that the electric door seal inflation system design does not provide adequate warning of a potential overheat situation. The system incorporates an amber (caution) light on the pilot's instrument panel that illuminates when the pump is operating. The STC installation instructions specify that a placard be placed near the light stating, "CAUTION/DOOR SEAL PUMP ON." However, no information is provided on action to take if the light remains illuminated for an extended period.

The Safety Board concludes that the Bob Fields Aerocessories door seal inflation system design does not provide owners or operators with adequate information about corrective action if the system begins to overheat. Also, it may not become apparent to an operator that the system is overheating until there are indications of an electrical fire. The system design does not incorporate its own electrical cut-off switch; therefore, the pilot's only means to address an overheating system or component is to turn off the airplane's entire electrical power system using the master switch.

The Safety Board is very concerned that these design deficiencies increase the likelihood of an in-flight electrical fire and/or smoke in the cockpit during flight, as evidenced by the accident and incidents discussed above, as well as additional incidents identified by SDRs. Therefore, the Safety Board believes that the FAA should issue an airworthiness directive to require that all owners and operators of airplanes equipped with electric door seal inflation pump systems manufactured by Bob Fields Aerocessories immediately disconnect them from the airplanes' electrical systems. In addition, the FAA should review all STCs that provide for the installation of electric door seal inflation pump systems manufactured by Bob Fields Aerocessories, and require revisions, as necessary, to ensure that the hazards associated with in-flight fire and/or smoke in the cockpit during flight are eliminated. Existing systems should be required to comply with those instructions before they are placed back into service.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an airworthiness directive to require that all owners and operators of airplanes equipped with electric door seal inflation pump systems manufactured by Bob Fields Aerocessories immediately disconnect them from the airplanes' electrical systems. (Urgent) (A-98-109)
>
> Review all supplemental type certificates that provide for the installation of electric door seal inflation pump systems manufactured by Bob Fields Aerocessories, and require revisions, as necessary, to ensure that the hazards associated with in-flight fire and/or smoke in the cockpit during flight are eliminated. Existing systems should be required to comply with those instructions before they are placed back into service. (A-98-110)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Jim Hall

By: Jim Hall
Chairman

Enclosure

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 01/30/98

CHI98LA041
FILE NO. 640 11/20/97 BURLINGTON,KS AIRCRAFT REG NO. N3681K TIME (LOCAL) - 08:30 CST

MAKE/MODEL -Beech-95-B55
ENGINE MAKE/MODEL -Continental IO-470-L
AIRCRAFT DAMAGE -Substantial
NUMBER OF ENGINES -2
OPERATING CERTIFICATES -NONE
TYPE OF FLIGHT OPERATION -Personal
REGULATION FLIGHT CONDUCTED UNDER -14 CFR 91

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	1
PASS	0	0	1

LAST DEPARTURE POINT - ROGERS, AR
DESTINATION - CONCORDIA,KS

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 8.000 SM
WIND DIR/SPEED - 180 /016 KTS
TEMPERATURE (F) - 42
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 39

CERTIFICATES/RATINGS
Private
Single-engine land, Multiengine land
INSTRUMENT RATINGS
Airplane

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 1323
LAST 90 DAYS - 38
TOTAL MAKE/MODEL - 201
TOTAL INSTRUMENT TIME - 221

The pilot said they were about 40 minutes into their flight when "my passenger and I heard the pneumatic door seal give way." He recycled the switch, but nothing happened. A few minutes later, the pilot and passenger noticed "the faint smell of electrical burn." The pilot switched the heater off and the smell seemed to subside. He switched the heater back on and noticed a stronger smell immediately. Black smoke began to enter the cabin from above and beneath the instrument panel. The pilot said that as he reached for the throttle, he noticed "that there was orange spark and flame under the panel." He initiated a steep descent and began looking for a place to land. He located a north-south running dirt road, and initiated a 180-degree turn to land. The pilot overshot the road and decided that he didn't have enough altitude and airspeed to maneuver back to the road. He leveled the airplane and landed in a field. During the landing, the airplane encountered uneven (rising) terrain and trees. An exam of the airplane revealed the door seal inflation pump was heavily charred. An exam of the cabin revealed the door inflation seal around the cabin door was missing, both forward air vents were in the open position, and plastic insulation surrounding electrical wiring in front of the right air vent was melted. Melted plastic was observed on the floor, beneath the right side air vent. No other anomaly was found.

CHI98LA041
FILE NO.640 11/20/97 BURLINGTON,KS AIRCRAFT REG NO. N3681K TIME (LOCAL) - 08:30 CST

Occurrence# 1 FIRE
Phase of operation CRUISE

Findings
1. AIR COND/HEATING/PRESSURIZATION - UNDETERMINED
2. EMERGENCY PROCEDURE - NOT PERFORMED - PILOT IN COMMAND
3. ELECTRICAL SYSTEM,ELECTRIC WIRING - MELTED

Occurrence# 2 IN FLIGHT COLLISION WITH OBJECT
Phase of operation EMERGENCY LANDING

Findings
4. PRECAUTIONARY LANDING - MISJUDGED - PILOT IN COMMAND
5. OBJECT - TREE(S)

Occurrence# 3 IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of operation EMERGENCY LANDING

The National Transportation Safety Board determines the probable cause(s) of this accident was:
an undetermined event resulting in the door seal inflation pump catching fire, the pilot's failure to close the cockpit air vents allowing heat and flames from the airplane's nose section to melt electrical wiring behind the instrument panel, and the pilot overshooting the road during his precautionary landing. A factor contributing to this accident was the trees.

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: H-98-41

Honorable Kenneth R. Wykle
Administrator
Federal Highway Administration
Washington, D.C. 20590

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

Among other issues, the Safety Board investigation examined the adequacy of the design, maintenance, inspection, and drainage area characteristics of BNSF bridge 504.1[2] in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

[2]The BNSF designates bridges by their milepost numbers. There are two separate bridges at milepost 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

crosswall and the bridge supporting structure. The investigation raised concerns regarding the highway box culverts downstream from bridge 504.1.

Following the accident, the BNSF hired a consultant, HDR Engineering, Inc., to conduct a site reconnaissance, surface exploration, and laboratory testing of soils from the site. In its report to the BNSF, [3] HDR Engineering noted concerns regarding the concrete box culverts under Arizona State Route 66 adjacent to and downstream of the BNSF bridges in the accident area. Results of the BNSF hydrology study revealed that the highway box culvert downstream from railroad bridge 504.1 was apparently engineered to withstand a 25-year flood. According to the study,

> At this time, based on the bed degradation which has developed below all five of the downstream highway 66 bridge structures, the highway structures have the potential of being washed out with the next major flood event, with the potential for the resultant headcut (of a potential magnitude of 5 feet) proceeding through the railway bridges (Br. 503.1, 504.1, and 505.9).

Arizona Department of Transportation (ADOT) inspectors did not find any significant problems with the bridge (box culvert) either during the last scheduled inspection in February 1997 or the postaccident inspection of August 12, 1997. Although scour observations and measurements were made by the ADOT inspector, no scour calculations were made during either inspection.

Although the Safety Board did not request that the BNSF conduct a hydrology study or a scour vulnerability assessment of either the highway box culvert or the railroad bridges for the Kingman investigation, the BNSF provided this information to the Safety Board in its report. The Safety Board is concerned about the statements made in the BNSF report regarding the vulnerability of the box culverts and the potential effect such culverts might have on the railroad bridges in another severe storm situation. However, the BNSF report did not include ADOT bridge inspection data or pictures of the streambed dating back to 1971,[4] information that would have been helpful in determining the relationship between the box culverts and the railroad bridges. The Safety Board therefore concluded that the relationship of the two structures and their respective zones of influence is not fully understood.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Federal Highway Administration:

> Examine the "System Analysis Seligman Subdivision Bridge No.'s 503.1-505.9" report and the Arizona Department of Transportation's historical bridge inspection data to determine the hydrologic relationship between the box culvert and bridge 504.1. If the examination determines that the structures have a detrimental hydrologic effect on each other, alert the States and the Federal Railroad

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[3] The report is entitled "System Analysis Seligman Subdivision Bridge No.'s 503.1-505.9."

[4] During 1971, the State of Arizona widened Arizona State Route 66 and extended the concrete box culvert downstream from BNSF bridge 504.1.

Administration that similarly related structures may be vulnerable to similar problems. (H-98-41)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

Please refer to Safety Recommendation H-98-41 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: H-98-42

Ms. Mary E. Peters
Director
Arizona Department of Transportation
206 S. 17th Avenue
Phoenix, Arizona 85007

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

Among other issues, the Safety Board investigation examined the adequacy of the design, maintenance, inspection, and drainage area characteristics of BNSF bridge 504.1[2] in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

[2]The BNSF designates bridges by their milepost numbers. There are two separate bridges at milepost 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

crosswall and the bridge supporting structure. The investigation raised concerns regarding the highway box culverts downstream from bridge 504.1.

Following the accident, the BNSF hired a consultant, HDR Engineering, Inc., to conduct a site reconnaissance, surface exploration, and laboratory testing of soils from the site. In its report to the BNSF, [3] HDR Engineering noted concerns regarding the concrete box culverts under Arizona State Route 66 adjacent to and downstream of the BNSF bridges in the accident area. Results of the BNSF hydrology study revealed that the highway box culvert downstream from railroad bridge 504.1 was apparently engineered to withstand a 25-year flood. According to the study,

> At this time, based on the bed degradation which has developed below all five of the downstream highway 66 bridge structures, the highway structures have the potential of being washed out with the next major flood event, with the potential for the resultant headcut (of a potential magnitude of 5 feet) proceeding through the railway bridges (Br. 503.1, 504.1, and 505.9).

As you are aware, ADOT inspectors did not find any significant problems with the bridge (box culvert) either during the last scheduled inspection in February 1997 or the postaccident inspection of August 12, 1997. Although scour observations and measurements were made by the ADOT inspector, no scour calculations were made during either inspection.

Although the Safety Board did not request that the BNSF conduct a hydrology study or a scour vulnerability assessment of either the highway box culvert or the railroad bridges for the Kingman investigation, the BNSF provided this information to the Safety Board in its report. The Safety Board is concerned about the statements made in the BNSF report regarding the vulnerability of the box culverts and the potential effect such culverts might have on the railroad bridges in another severe storm situation. However, the BNSF report did not include ADOT bridge inspection data or pictures of the streambed dating back to 1971, information that would have been helpful in determining the relationship between the box culverts and the railroad bridges. The Safety Board therefore concluded that the relationship of the two structures and their respective zones of influence is not fully understood.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Arizona Department of Transportation:

> Examine the "System Analysis Seligman Subdivision Bridge No.'s 503.1-505.9" report in light of your own historical bridge inspection information and take any action you deem appropriate. (H-98-42)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's

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[3] The report is entitled "System Analysis Seligman Subdivision Bridge No.'s 503.1-505.9."

Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation H-98-42 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 28, 1998

In reply refer to: P-98-21 through -23

Ms. Mary Ellen Peters
President
Marathon Ashland Pipe Line LLC
539 Main Street
Findlay, Ohio 45840

On May 23, 1996, a 68-mile-long, 20-inch-diameter steel pipeline owned by Marathon Pipe Line Company ruptured at a location near Gramercy, Louisiana. The rupture went undetected by the pipeline controller for about 1 hour. The ruptured pipeline ultimately released about 475,000 gallons of gasoline into a common pipeline right-of-way within a designated "wetland." Gasoline also entered the Blind River, causing environmental damage and killing fish, wildlife, and vegetation in the area.

The National Transportation Safety Board determined that the probable cause of the accident was damage done to the Marathon pipeline during excavations of a nearby pipeline operated by LaRoche Industries, Inc., which resulted from the failure of LaRoche either to take adequate measures to ensure that excavations performed under its supervision did not damage underground utilities or to notify Marathon that those excavations may have damaged the Marathon pipeline. Contributing to the severity of the accident was Marathon's delay in recognizing the rupture, which delayed shutting down the pipeline and isolating the rupture.

Shortly after the rupture, the supervisory control and data acquisition (SCADA) system in the Findlay, Ohio, control center displayed alarms consistent with a leak occurring between the Garyville and Zachary stations in Louisiana. The pipeline controller observed and acknowledged the series of alarms, but he did not associate the alarms with a possible pipeline leak until about an hour after the rupture had occurred. The Safety Board investigation determined that this delay was due to the fact that the pipeline operator did not immediately interpret the SCADA alarms as indicating a leak and instead associated the alarms with more common problems that could result in similar SCADA indications.

When the leak occurred, the SCADA system correctly reported that certain pumps had shut down at the Garyville refinery. Within 2 minutes, the SCADA system reported a line balance alarm and displayed a message indicating that less product was exiting the pipeline at Zachary than was being introduced at Garyville. The pipeline controller, however, because he believed that the alarms were due to activity at the Garyville refinery, did not read the entire displayed message on the SCADA monitor, thereby missing the opportunity to interpret the information as a leak in the pipeline. When the SCADA system repeated a display of the product volume information an hour later, the controller did note the abnormally low volume at Zachary and began taking actions to deal with the leak.

The controller said that after receiving the initial alarms, he called Garyville and discussed the situation with the station operator there. The station operator confirmed the pump shutdowns and informed the controller that the refinery was loading product to a barge.[1] Even though refinery personnel reported that the volume of product being delivered to the barge was insufficient to have caused the SCADA system to alarm, the pipeline controller and the station operator concluded that the loading of the barge had precipitated the alarms and the pump shutdowns.

The pipeline controller's confidence that the problem was related to refinery operations may have lessened the value he placed on subsequent alarms. In other words, his anticipation of a particular series of alarms may have reduced his vigilance in monitoring the automation and its parameters. Consequently, although the controller did observe the line balance alarm, he had already assessed the situation and therefore did not examine the numerical data closely enough to recognize that they signaled a leak.

Another possible reason the pipeline controller did not adequately attend to the alarms was the high concentration of alarms presented to him during a relatively short period of time. The line balance data was displayed during a high-workload situation, 11 seconds after the previous alarm and just 4 seconds before the next alarm. During periods of high workload, operators tend to focus on new alarm information at the top of a display panel or monitor and to ignore or attribute less importance to older alarm information as it scrolls down the display. As new data messages quickly displaced the line balance alarm from the top of the SCADA screen, the pipeline controller likely gave more attention to the incoming data and placed ever-diminishing value on older reports.

When the controller was unable to restart the pumping units, he became uncertain about the true source of the problem. About an hour after the initial alarm, the SCADA system reported a second line balance alarm. This alarm was received more than 7 minutes after the most recent alarm and more than 1 minute before the next alarm. Probably because of a combination of the lower workload represented by the increased time between alarms and the pipeline controller's renewed desire to find another explanation for the abnormal situation, the controller correctly attended to the latest data, made a quick interpretation of their significance, and took immediate action to remedy the situation.

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[1] According to Marathon employees, the high-volume delivery of product from the refinery to river barges sometimes decreased the pressure in the pipeline beyond a predetermined set point, which resulted in the automatic shutdown of pumping units and consequent SCADA system alarms. The resulting SCADA alarm messages were similar to what would be expected in the event of a leak except for the values of the numerical data associated with the line balance alarm.

Because the controller erroneously attributed the first line balance alarm to the effects of operations at the Garyville refinery, he did not access data that would have more conclusively indicated a leak. Although critical information was available from the SCADA system, the data were not displayed in a manner that prompted the controller to scrutinize them.

System safety depends on equipment design that considers the needs of the human operator. In high-workload situations, for instance, pipeline controllers can be at a great disadvantage if actions taken by the automated systems are not clearly displayed.[2] A problem in many complex systems is the lack of information salience that may accompany automation.[3] Cluttered displays reduce the perceptual salience of information, even if the data are available. In a complex environment with many activities occurring simultaneously, controllers may easily lose track of such information.

The investigation determined that Marathon's SCADA system did not have adequate safeguards or redundancies to assist the pipeline controllers with detecting vital information. In this accident, the 1 hour that elapsed between the first and second line balance data alarms limited the pipeline controller's opportunity to detect deviations in normal operating conditions and thus to determine that a leak had occurred in the pipeline.

The pipeline controller reported that the SCADA system, as configured at the time of the accident, would typically report well over 100 alarms during a 12-hour shift. The majority of these were low-priority or informational alarms serving mostly to report that the operator had just made a particular SCADA input. Marathon pipeline controllers have termed these low-priority reports "nuisance alarms." Because of the frequency of such alarms, pipeline controllers may not have responded to them with appropriate vigilance. The Safety Board notes that since the accident, Marathon has taken measures to improve the likelihood that pipeline controllers will be alerted to leaks and will respond appropriately. For example, Marathon has substantially reduced the frequency of nuisance alarms to ease the workload of the pipeline controllers and increase the likelihood of their detecting important changes to the operations. The Safety Board commends Marathon for taking such action but believes that additional changes are necessary to ensure timely response to future pipeline emergencies.

Even though the controller determined shortly after 11 p.m. that a leak had occurred and took action to shut the line down and isolate the leak, Marathon crews did not complete manual closure of valves on either side of the rupture until about 2:30 a.m. The Safety Board notes that some hazardous liquid pipeline operators have installed remotely or automatically operated valves (including check valves) in their pipelines. Some of these operators have designed their systems carefully and have taken steps to prevent inadvertent valve closures or to avoid excessive pipeline pressures should a valve close unexpectedly. Some of these measures have included selecting appropriate controls and fail-safe positioning during communication failures, selecting optimum

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[2] Van Cott, H., Wiener, E., Wickens, C., Blackman, H., and Sheridan, T., "Smart Automation Enhances Safety: A Motion for Debate," *Ergonomics in Design*, Vol. 4, No. 4, 1996.

[3] Endsley, M.R. "Automation and Situation Awareness," *Automation and Human Performance: Theory and Applications*, Parasuraman, R., and Mouloua, M. (Eds.), 1996, Lawrence Erlbaum Associates, N.J.

valve closure times, shutting down pumping stations during indications of possible valve closure or certain communications failures, carrying out strict maintenance procedures, and building in surge and lightening protection.

The National Transportation Safety Board therefore makes the following safety recommendations to Marathon Ashland Pipe Line LLC:

> Use recurrent pipeline controller training to (1) emphasize the importance of carefully and completely reading the text of and evaluating all alarm messages, and (2) increase controller proficiency in interpreting and responding to control system data that may indicate a system leak. (P-98-21)
>
> Evaluate the effectiveness of alternative display formats and frequencies of alarming critical information for your supervisory control and data acquisition system and modify the system as necessary to ensure that controllers are specifically prompted to consider the possibility of leaks during system deviations that are consistent with a loss of product from a pipeline. (P-98-22)
>
> Evaluate remote and automatic valve control technology to facilitate the rapid isolation of damaged or leaking pipelines, and incorporate the appropriate valve control technology in your pipeline system, especially in those segments located in urban or environmentally sensitive areas. (P-98-23)

Also, the Safety Board issued Safety Recommendation P-98-24 to LaRoche Industries, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations P-98-21 through -23 in your reply. If you need additional information, you may call (202) 314-6469.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 28, 1998

In reply refer to: P-98-24

Mr. Grant O. Reed
President and Chief Executive Officer
LaRoche Industries, Inc.
1100 Johnson Ferry Road, N.E.
Atlanta, Georgia 30342

On May 23, 1996, a 68-mile-long, 20-inch-diameter steel pipeline owned by Marathon Pipe Line Company ruptured at a location near Gramercy, Louisiana. The rupture went undetected by the pipeline controller for about 1 hour. The ruptured pipeline ultimately released about 475,000 gallons of gasoline into a common pipeline right-of-way within a designated "wetland." Gasoline also entered the Blind River, causing environmental damage and killing fish, wildlife, and vegetation in the area.

The National Transportation Safety Board determined that the probable cause of the accident was damage done to the Marathon pipeline during excavations of a nearby pipeline operated by LaRoche Industries, Inc. The damaged pipeline was the result of the failure of LaRoche either to take adequate measures to ensure that excavations performed under its supervision did not damage underground utilities or to notify Marathon that those excavations may have damaged the Marathon pipeline. Contributing to the severity of the accident was Marathon's delay in recognizing the rupture, which delayed shutting down the pipeline and isolating the rupture.

Investigation of the rupture site revealed an approximate 200- by 100-foot excavation area that extended over the Marathon pipeline and included the rupture site. Safety Board investigators found a longitudinal crack approximately 53 inches long near the top of the pipe. In the vicinity of the crack were multiple dents, scrapes, and gouges that were consistent with damage that would be made by a backhoe or similar digging tool.

In September and October 1995, LaRoche supervised excavation of its 8-inch pipeline, which was located about 30 feet from the Marathon pipeline. The investigation revealed that neither LaRoche nor its excavation contractor used the Louisiana One Call system before beginning work at the site of the eventual rupture. Nor was any evidence found to indicate that LaRoche or its excavation contractor made any attempt to coordinate the excavation activities with Marathon or any of the other operators with pipelines in the vicinity of the excavation near the rupture site. According to officials from the excavation contractor, the equipment operators were told by LaRoche superintendents that no pipelines were located in the area of the Marathon pipeline. A LaRoche superintendent who supervised the excavation stated that when the excavation work was completed, the excavation crew did not fill in the excavated area.

The investigation revealed that no excavation other than that performed by LaRoche had been done in the area of the rupture since at least May 1990. This, in combination with the information above, led the Safety Board to conclude that the damage that was found on the pipeline and that was determined to have caused the rupture had occurred during the 1995 LaRoche excavation.

The Safety Board is concerned that neither LaRoche nor its excavation contractor used the Louisiana One Call system before beginning work in the area of the Marathon pipeline. Of equal concern to the Safety Board was the failure of LaRoche to take any action or make any notification when its excavation work encountered and damaged the pipeline. Based on the extent and nature of the damage, the Safety Board does not believe it reasonable that those individuals engaged in the excavation were unaware that their equipment had struck the pipeline. Despite the nature of the damage and its potential for causing the pipeline to fail, LaRoche personnel who were supervising the excavation made no effort to identify and notify the pipeline owner so that the damage could be assessed and possible corrective measures taken. Had LaRoche supervisors notified Marathon that its pipeline may have been damaged, repairs or replacements could have been made that would have prevented this accident.

LaRoche, in April 1998, implemented a written policy for repairing its 8-inch pipeline that includes requirements to notify the Louisiana One Call system before beginning excavations. LaRoche has told the Safety Board that all its future excavations will be preceded by notification of the Louisiana One Call system. The Safety Board notes LaRoche's efforts to address this issue; however, as noted previously, another serious issue in this accident involves LaRoche employees' actions, or inaction, during the course of and after completing the excavation work.

Therefore, the National Transportation Safety Board makes the following safety recommendation to LaRoche Industries, Inc.:

> Establish and implement comprehensive written excavation procedures to ensure that, if suspected damage to a facility occurs during excavation, all relevant authorities or entities are notified so that the situation can be evaluated and any corrective actions needed can be undertaken promptly. (P-98-24)

Also, the Safety Board issued Safety Recommendations P-98-21 through -23 to Marathon Ashland Pipe Line LLC.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation P-98-24 in your reply. If you need additional information, you may call (202) 314-6469.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-48 through -53

Mr. Robert D. Krebs
President and Chief Executive Officer
Burlington Northern Santa Fe Corporation
2650 Lou Menk Drive
Fort Worth, Texas 76161

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the BNSF tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

In its investigation, the Safety Board identified a number of concerns regarding the safety of structures subject to damage in severe storms and the protection of employees on or adjacent to the track in the performance of their duties. With regard to the failure of bridge 504.1S, the investigation examined the adequacy of the design, maintenance, inspection, and drainage area characteristics of bridge 504.1S in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a crosswall and the bridge supporting structure.

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[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

Bridge 504.1S was supported by a shallow foundation consisting of timber mud sills and timber blocking. BNSF records showed that the bridge supports were susceptible to scouring and erosion as early as 1959, when it was necessary to add stones and grout to a portion of the streambed. In the succeeding years, additional stones and grouting were added. Records also showed that, in 1975, maintenance personnel were still concerned about the bridge supporting structure and its water-carrying capacity. In fact, they remained so concerned that they recommended that the bridge be placed on the Capital Improvement Program (CIP) list for replacement.

BNSF bridge records identifying the size of the drainage area for bridge 504.1 were inconsistent. One record showed the drainage area as encompassing 3.8 square miles, while another showed the drainage area as totaling 19.09 square miles. The size of the drainage area is an important element in determining the required waterway opening for drainage structures. After the accident, the BNSF's consultant (HDR Engineering, Inc.) determined that the drainage area for bridge 504.1 was 19.5 square miles. The consultant's report cited the accepted engineering practice of using the 100-year storm criteria to provide for drainage structures but noted that local conditions and circumstances, such as the desert nature of the Kingman area, allowed for making an engineering judgment resulting in higher or lower values. According to the consultant's report, the bridges located at milepost 504.1 at the time of the accident were capable of withstanding a 24-year storm. The storm related to this accident was determined to have been approaching a 50-year storm event of 2 hours' duration. (The August 9, 1997, storm's effect differed among the five railroad bridges in the area. Bridge 504.1 experienced an approximate 50-year storm event, while bridge 503.7, for example, experienced an approximate 10-year storm event.) The bridge with which the BNSF replaced bridge 504.1 following the accident is capable of withstanding a 40-year storm.

In 1975, Atchison, Topeka and Santa Fe Railway (BNSF)[2] management placed bridge 504.1 on the 1977 CIP replacement program because the results of engineering studies raised concerns about the bridge's ability to provide an adequate waterway opening and about recurring erosion problems. In early 1976, however, Atchison, Topeka and Santa Fe Railway (BNSF) bridge maintenance personnel made a field decision to build an unreinforced concrete crosswall on the downstream side of bridge 504.1. Bridge 504.1 was subsequently removed from the 1977 replacement program.

Only two instances of high water were recorded for bridge 504.1 and both took place in 1976. This was after 1971 work affecting the box culverts downstream from the BNSF bridges had been performed by the Arizona Department of Transportation (ADOT) and after bridge 504.1 had been removed from the CIP budget list. Before the 1997 derailment at bridge 504.1S, no accidents involving high water or bridge failure were recorded for the Kingman area.

The purpose of the unreinforced concrete crosswall was to allow silt to back up and accumulate around the mud sills, thus acting to mitigate further scouring and erosion. However,

[2]At this time, the merger between the Atchison, Topeka and Santa Fe Railway and the Burlington Northern Railroad had not yet taken place.

no engineering evaluation was performed on the design and construction of the unreinforced concrete crosswall to determine the necessary anchorage, the appropriate size, the need for reinforcement, or the hydrologic characteristics of the waterway.

The severe flash flooding and resultant stream flow between bridge 504.1 and Arizona State Route 66 caused severe erosion that rapidly progressed upstream. The Safety Board cannot determine whether channel improvements made in 1971 contributed to this development, but evidence of streambed erosion was found during the on-site investigation. This erosion progression caused the failure of the unreinforced concrete crosswall because it was not anchored and was only 33 inches in depth. Because it was unreinforced, the crosswall broke into several pieces when its shallow footing was undermined.

When the concrete crosswall failed, the rate of erosion accelerated through the accumulated silt to the point that it quickly progressed to the shallow foundation of the bridge. This process undermined the bridge's mud sills and timber blocking and compromised the bridge's ability to support Amtrak train 4. The Safety Board therefore concluded that the failure of the bridge 504.1S was caused by scour and erosion affecting the inadequately protected shallow foundations that supported the bridge; the scour resulted because a poorly designed concrete crosswall was built instead of a new and better-engineered bridge.

Another concern arose during the investigation. In its report to the BNSF,[3] HDR Engineering noted concerns regarding the concrete box culverts under Arizona State Route 66 adjacent to and downstream of the BNSF bridges in the accident area. Results of the BNSF hydrology study revealed that the highway box culvert downstream from railroad bridge 504.1 was apparently engineered to withstand a 25-year flood. According to the study,

> At this time, based on the bed degradation which has developed below all five of the downstream highway 66 bridge structures, the highway structures have the potential of being washed out with the next major flood event, with the potential for the resultant headcut (of a potential magnitude of 5 feet) proceeding through the railway bridges (Br. 503.1, 504.1, and 505.9).

ADOT inspectors did not find any significant problems with the bridge (box culvert) either during the last scheduled inspection in February 1997 or the postaccident inspection of August 12, 1997. While scour observations and measurements were made by the ADOT inspector, no scour calculations were made during either inspection. ADOT did not require scour calculations.

Although the Safety Board did not request that the BNSF conduct a hydrology study or a scour vulnerability assessment of either the highway box culvert or the railroad bridges for the Kingman investigation, the BNSF provided this information to the Safety Board in its report. The Safety Board is concerned about the statements made in the BNSF report regarding the vulnerability of the box culverts and the potential effect such culverts might have on the railroad bridges in another severe storm situation. However, the BNSF report did not include ADOT

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[3] "The report is entitled "System Analysis Seligman Subdivision Bridge No.'s 503.1-505.9."

bridge inspection data or pictures of the streambed dating back to 1971, information that would have been helpful in determining the relationship between the box culverts and the railroad bridges. The Safety Board therefore concluded that the relationship of the highway box culverts and the railroad bridges and their respective zones of influence is not fully understood.

The Safety Board investigation found deficiencies in the inspection procedures used by the BNSF when the flash flooding occurred in the Kingman area. The BNSF track supervisor inspecting the track and bridges stated that on the day of the accident he took no exception to anything that he observed. He stated that, based on his knowledge of bridge inspections at that time, he felt, "Completely 100 percent confident that my railroad was able to support traffic of any nature after I had made the inspection." He stated that if he had observed debris under the bridge, he would have become concerned, notified the dispatcher to stop trains in that area, and requested help from a roadmaster. He also stated that he had no knowledge that one bridge would be less able to support train traffic than another.

On the day of the accident, the presence of water above the bridge foundation would have prevented thorough inspection of the bridge supporting structure by anyone, even a qualified bridge inspector. However, the high water levels could have indicated a potential for structural failure of the bridge foundations. A track inspector with relevant bridge inspection training could have recognized that the flooding had the potential to cause problems with several bridges in the Kingman area—including bridge 504.1—and taken measures to stop train traffic until a thorough inspection of the bridge supporting structure could be conducted.

The Safety Board appreciates that, following the Kingman accident, the BNSF developed a 1-hour training program concerning bridge inspections for maintenance-of-way employees. The training describes various types of bridges and their supporting structures (such as shallow-foundation and deep-foundation bridges) and "tell-tale" signs that the structure may have been damaged. The track supervisor who inspected bridge 504.1 on the day of the accident has since taken the BNSF training, and, in hindsight, found that his knowledge of bridges at the time of the derailment would not have been adequate for him to assess possible damage.

For instance, before his training, the track supervisor was not alarmed by the presence of high water under bridge 504.1; however, since his training, he recognizes the possibility of the bridge supporting structure being damaged as a result of any amount of water around it. The BNSF expects that this training will provide basic insight for track inspectors to recognize the types of bridges susceptible to damage in severe flash flooding conditions when a qualified bridge inspector is not immediately available to perform an inspection. Also, it will teach track inspectors to stop trains before they reach the bridge if they have any doubt as to the bridge's safety. (The program has not been in place long enough to evaluate its effectiveness.)

Before the training program was instituted, the BNSF should not necessarily have relied on its track inspectors to adequately assess possible bridge damage caused by flooding conditions; rather, the BNSF should only have relied on qualified bridge inspectors to perform these inspections. In this case, had the qualified bridge inspector for the area been notified immediately of the flash flooding near Kingman, he would not have arrived in time to have inspected the bridge before Amtrak train 4 derailed. When the derailment occurred, the bridge inspector assigned to this area was at home, on vacation, and he told investigators that it would have taken him at least 4 1/2 hours to drive to Kingman. Therefore, additional responsibility (such as for bridge inspections) was placed on the track supervisor, who at that time had not been trained to recognize the potential damage flood waters could cause to bridge foundations.

Because the track supervisor was not a qualified bridge inspector and had not received formal training in this area, he was ill-prepared to complete rudimentary bridge inspections. The BNSF understood that, during flooding conditions, a bridge inspector could take several hours to arrive on scene. As a result, the responsibility for ensuring the integrity of both the track and bridges was often placed on the track inspector (or, in this case, the track supervisor). The Safety Board concluded that Amtrak train 4 derailed when bridge 504.1S failed because the BNSF maintenance-of-way managers lacked proper foresight and planning regarding the assignment or training or both of personnel designated to conduct bridge inspections during severe weather.

Another concern raised by the Kingman accident was BNSF protection of trains during severe weather. On August 10, 1997, (the day after the accident) the BNSF issued a policy for trains operating during severe flooding through a Maintenance Alert. The Maintenance Alert was subsequently updated on February 20, 1998, because of severe storm-related conditions and traffic delays that affected the BNSF's Northern California Division through the San Joaquin Valley. The updated version of the alert is applicable only for that BNSF division. Trains on all other BNSF divisions must comply with the August 10, 1997, Maintenance Alert requirements of 40 mph for freight trains and "restricted speed" for passenger trains until the weather warning expires.

In the February 20, 1998, version, the train speed restrictions for both freight and passenger trains were relaxed from the earlier Maintenance Alert. When weather warnings are issued for a "flash flood warning," freight and passenger trains are restricted to 40 mph and 50 mph, respectively, except in the areas where the 14 bridges have been identified as being vulnerable to scour because their foundations do not have piling. In those instances, the BNSF's passenger trains and "key trains" (those transporting hazardous materials) are required to operate at restricted speed, but all other freight trains can operate at 40 mph. The Maintenance Alert stays in effect until the weather warning expires.

The Safety Board recognizes the added safety for the train crews and passengers provided by reducing the speed of the passenger trains to a level from which they can be stopped in a relatively short distance in the event of an emergency. The Safety Board does not understand, however, the safety rationale for BNSF freight train crews being permitted to travel at speeds that may still require stopping distances of up to a mile.

The Safety Board concluded that when, because of flash flooding conditions, the integrity of bridges has yet to be validated, it is critical that trains be operated at a reduced speed such as "restricted speed." Train operations at restricted speed provide a margin of safety for the engineer to operate the train at a speed slow enough, while not exceeding 20 mph, to be able to safely stop the train within one-half his range of vision, which could be affected by weather conditions such as heavy rain or darkness or both. A thorough analysis is needed to determine the appropriate personnel, inspection, and operating policies to be used during flash flooding conditions and establish procedures designed to ensure the safe passage of all trains. The analysis should address the minimum training requirements for personnel responding to emergency inspections and should evaluate current inspection procedures and response actions to determine their adequacy during abnormal or emergency situations.

Finally, the Kingman accident investigation indicated that the BNSF could improve the protection it provides to its employees on or adjacent to the track in the performance of their duties. The Federal Railroad Administration (FRA) was required by the Rail Safety Enforcement and Review Act of September 3, 1992, to review the Track Safety Standards and revise them based on information derived from that review. One of the issues identified to be addressed was the safety of maintenance-of-way employees working on or along the railroad right-of-way. This issue was separated from the ongoing review of the Track Safety Standards and assigned to a separate Railroad Safety Advisory Committee, which was to study the issue and develop recommendations.

As part of this study, FRA records identified 22 fatalities that occurred in the period between 1989 and 1993. An independent labor-management task force focused on 43 accidents that resulted in 46 fatalities and 150 injuries from 1986 through 1994. Most of the fatalities occurred while some form of protection system was available or in use. Through this process, the FRA initiated rulemaking activity, which resulted in the Roadway Worker Protection (RWP) regulations (found in 49 *Code of Federal Regulations* 214) that became effective January 15, 1997.

The track supervisor involved in the Kingman accident was, while inspecting the main track, operating with a track car operator informational line-up. This practice was permissible under the requirements of the FRA RWP regulations.

Class I railroads, including the BNSF, were required to be in compliance with the new regulations as of March 15, 1997. The regulations also provided that carriers each prepare a plan for compliance and notify the FRA, at least 1 month before March 15, 1997, that its plan was prepared and available for FRA review.

The RWP regulations permitted railroads that used informational line-ups as of March 14, 1996, to continue using them. However, the RWP regulations also required that the carrier's plan for compliance with the regulations contain a schedule for the discontinuance of the informational line-up procedure by a definite date.

The BNSF developed a plan as required by the regulations and notified the FRA before March 15, 1997. The plan called for the use of both train location line-ups and track car operator line-ups to be discontinued by August 1, 2016. The FRA reviewed this plan with the BNSF on April 9, 1997, at BNSF headquarters in Fort Worth, Texas. (As of July 14, 1998, the FRA had not approved the BNSF plan.)

An internal BNSF memorandum, dated February 13, 1998, stated that, as of January 29, 1998, train location/track car operator line-ups were still in use on 14 branch lines and 4 main line subdivisions. The memo further stated that, although the BNSF had committed to discontinue the use of these line-ups by August 1, 2016, ongoing efforts were underway to employ alternate methods wherever possible, given communications constraints. The BNSF timeline for eliminating the use of line-ups was tied to expansion of cellular telephone coverage on remote territories and implementation of emerging control and voice communications technologies.

Although the operational practices that the track supervisor used during his special inspection were not factors in the derailment of Amtrak train 4, the Safety Board is concerned about the potential risk to employees engaged in special inspections while located on or adjacent to the railroad tracks. In this accident, the track supervisor confirmed that no mechanism was in place to protect him or other track inspectors if they could not contact the dispatcher for any reason. He considered it the employee's responsibility to get out of the way of trains. Track inspectors believe that their protection lies in the informational line-up, even though they know that the line-up is only valid for about 4 hours and that the dispatcher would not try to locate them. This practice places the responsibility on the employee to protect himself, and generally he can. If, however, the track inspector becomes incapacitated, or the communications equipment fails, or the dispatcher does not stop trains from entering the area occupied by the inspector, the inspector could be put in jeopardy.

The RWP regulations were intended to provide protection and safety for on-track workers. They specifically address the need to discontinue the use of informational line-ups as the sole protection for track inspectors. The Safety Board concluded that the BNSF's 18-year timeframe for discontinuing the practice of using informational line-ups to ensure worker safety is too long and, until eliminated, the practice has the potential to place railroad workers in danger.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Burlington Northern Santa Fe Corporation:

> Identify and perform a risk assessment of all system bridges that have shallow foundations of similar construction to the bridge that failed in the Kingman, Arizona, accident, and replace those bridges determined to be susceptible to undermining and loss of the supporting foundation structure. In conjunction with the risk assessment, perform a hydrology study on shallow foundation structures with questionable drainage areas to determine their current drainage areas. (R-98-48)
>
> Evaluate, and improve as necessary, your basic bridge inspection training program for track inspectors to ensure that appropriate procedures are used in emergency situations. (R-98-49)
>
> Require your management to periodically review bridge inspection training for track inspectors to ensure that it meets program objectives. (R-98-50)
>
> Conduct a thorough analysis to determine the appropriate personnel, inspection, and operating policies to be used during flash flooding conditions, and establish procedures designed to ensure the safe passage of all trains. The analysis should address the minimum training requirements for personnel responding to emergency inspections and evaluate current inspection procedures and response actions to determine their adequacy during abnormal or emergency situations. (R-98-51)

Change your policy regarding freight train operating speeds so that it is consistent with the required operating speeds of other trains during flash flooding weather warnings, as noted in the August 1997 Burlington Northern Santa Fe Maintenance Alert. (R-98-52)

Immediately discontinue the use of informational line-ups. (R-98-53)

Also, the Safety Board issued Safety Recommendations R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-98-48 through -53 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Jim Hall

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-54 through -57

Honorable Jolene M. Molitoris
Administrator
Federal Railroad Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

In its investigation, the Safety Board identified concerns regarding the safety of structures subject to damage in severe storms, the protection of trains during severe weather conditions, and passenger safety and emergency response procedures, among other issues. In addition, the Safety Board investigated the use of locomotive event recorders.

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

With regard to the failure of bridge 504.1S,[2] the investigation examined the adequacy of the design, maintenance, inspection, and drainage area characteristics of bridge 504.1S in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a crosswall and the bridge supporting structure. Bridge 504.1S was supported by a shallow foundation consisting of timber mud sills and timber blocking. BNSF records showed that the bridge supports were susceptible to scouring and erosion as early as 1959, when it was necessary to add stones and grout to a portion of the streambed. In the succeeding years, additional stones and grouting were added. Records also showed that, in 1975, maintenance personnel were still concerned about the bridge supporting structure and its water-carrying capacity. In fact, they remained so concerned that they recommended that the bridge be placed on the Capital Improvement Program (CIP) list for replacement.

BNSF bridge records identifying the size of the drainage area for bridge 504.1 were inconsistent. One record showed the drainage area as encompassing 3.8 square miles, while another showed the drainage area as totaling 19.09 square miles. The size of the drainage area is an important element in determining the required waterway opening for drainage structures. After the accident, the BNSF's consultant (HDR Engineering, Inc.) determined that the drainage area for bridge 504.1 was 19.5 square miles. The consultant's report cited the accepted engineering practice of using the 100-year storm criteria to provide for drainage structures but noted that local conditions and circumstances, such as the desert nature of the Kingman area, allowed for making an engineering judgment resulting in higher or lower values. According to the consultant's report, the bridges located at milepost 504.1 at the time of the accident were capable of withstanding a 24-year storm. The storm related to this accident was determined to have been approaching a 50-year storm event of 2 hours' duration. (The August 9, 1997, storm's effect differed among the five railroad bridges in the area. Bridge 504.1 experienced an approximate 50-year storm event, while bridge 503.7, for example, experienced an approximate 10-year storm event.)

In 1975, railroad management placed bridge 504.1 on the 1977 CIP replacement program because the results of engineering studies raised concerns about the bridge's ability to provide an adequate waterway opening and about recurring erosion problems. In early 1976, however, railroad bridge maintenance personnel made a field decision to build an unreinforced concrete crosswall on the downstream side of bridge 504.1. Bridge 504.1 was subsequently removed from the 1977 replacement program.

Only two instances of high water were recorded for bridge 504.1 and both took place in 1976. This was after 1971 work affecting the box culverts downstream from the BNSF bridges had been performed by the Arizona Department of Transportation and after bridge 504.1 had been removed from the CIP budget list. Before the 1997 derailment at bridge 504.1S, no accidents involving high water or bridge failure were recorded for the Kingman area.

The purpose of the unreinforced concrete crosswall was to allow silt to back up and accumulate around the mud sills, thus acting to mitigate further scouring and erosion. However,

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[2]The BNSF designates bridges by their milepost numbers. There are two separate bridges at milepost 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

no engineering evaluation was performed on the design and construction of the unreinforced concrete crosswall to determine the necessary anchorage, the appropriate size, the need for reinforcement, or the hydrologic characteristics of the waterway.

The severe flash flooding and resultant stream flow between bridge 504.1 and Arizona State Route 66 caused severe erosion that rapidly progressed upstream. The Safety Board cannot determine whether channel improvements made in 1971 contributed to this development, but evidence of streambed erosion was found during the on-site investigation. This erosion progression caused the failure of the unreinforced concrete crosswall because it was not anchored and was only 33 inches in depth. Because it was unreinforced, the crosswall broke into several pieces when its shallow footing was undermined.

When the concrete crosswall failed, the rate of erosion accelerated through the accumulated silt to the point that it quickly progressed to the shallow foundation of the bridge. This process undermined the bridge's mud sills and timber blocking and compromised the bridge's ability to support Amtrak train 4. The Safety Board therefore concluded that the failure of the bridge 504.1S was caused by scour and erosion affecting the inadequately protected shallow foundations that supported the bridge; the scour resulted because a poorly designed concrete crosswall was built instead of a new and better-engineered bridge.

The Safety Board also investigated the issue of the protection of trains during severe weather conditions. The Safety Board acknowledges the prompt action taken by the FRA in issuing its Safety Advisory 97-1 for special inspection procedures for bridges, following the Kingman accident. The Safety Board, however, is concerned because the items listed in the FRA's advisory are only recommended; they are not regulatory requirements. When issuing the advisory, the FRA cited the Track Safety Standards (49 *Code of Federal Regulations* 213), which state in part, "In the event of fire, flood, severe storm, or other occurrence which might have damaged track structure, a special inspection must be made of the track involved as soon as possible after the occurrence..." as justification for the advisory. The FRA stated that it purposely made this provision general in nature, because, "It is not practicable to specify in a minimum safety standard all the conditions which could trigger a special inspection, nor the manner in which any particular special inspection must be conducted." The FRA believed, "It is more effective to provide information and guidance to the railroad industry, which each railroad can then adapt to its own circumstances."

Although bridge inspections during severe weather circumstances are not mentioned in the FRA's Track Safety Standards, it appears that the FRA assumes that the language in Part 213.239 is a "catch-all" for everything that should be done but is not specifically addressed. Had the FRA's Safety Advisory 97-1 been in effect before the accident, the BNSF may have: had a program in place to identify those bridges that had specific features susceptible to damage in severe weather; analyzed the potential for damage to those bridges; and made that information available to those responsible for inspecting the bridges in such situations.

In the Kingman accident, however, the track supervisor did not have this type of information before the accident. If he had had this information, he should have been able to recognize the susceptibility of bridge 504.1S to damage during the severe flash flooding and could have taken action to stop trains until an appropriate inspection could be made by a bridge inspector; alternatively, he could have halted train traffic until the water subsided and it could be determined that the bridge was not in danger. The Safety Board concluded that, had the FRA issued minimum standards for special inspection procedures for bridges that would be at risk during severe weather, such as those standards recommended in its Safety Advisory 97-1, the BNSF track supervisor would have had better guidance for making the special inspection. Because the FRA issued the safety advisory as an informational guideline, it has already taken the first step in specifying some minimum safety standards for bridge inspection.

Passenger safety in emergency conditions was another concern raised by the Kingman accident. The failure of emergency electrical systems to provide emergency power can be a serious problem in critical situations such as derailments. The emergency electrical system for each passenger car on train 4 was either at minimal output or at no power as a result of the derailment. Extensive undercarriage damage resulted in severed wiring and electrical conduits. Consequently, neither the interior emergency lights nor the public address system was reliable for operation, and no back-up system was provided. Passengers either had to rely on the instructions they were given by the Amtrak personnel in their car or to evacuate the train on their own.

In the Kingman accident, the Amtrak light sticks provided sufficient emergency lighting until the arrival of emergency responders. Light stick use was limited, but the usefulness of the light sticks was well acknowledged by the passengers, and they provided a measure of safety when the emergency lighting failed. The Safety Board is concerned, however, that not enough is being done to provide for passenger safety when emergency power is lost. In the 1996 Silver Spring accident,[3] a contributing factor to the severity of the accident and the loss of life was the lack of appropriate regulations to ensure adequate emergency egress features on railroad passenger cars. One of the safety recommendations issued following this investigation called for the FRA to:

> <u>R-97-17</u>
>
> Require all passenger cars to contain reliable emergency lighting fixtures that are each fitted with a self-contained independent power source and incorporate the requirements into minimum passenger safety standards.

On February 25, 1998, the FRA responded to this safety recommendation, stating that:

> FRA findings in recent accidents support the Safety Board's implied concern that placement of electrical conduits and battery packs below the floor of passenger coaches can result in damage that leads to the unavailability of emergency lights precisely at the time they are most needed. However, from initial investigation it is not certain whether current 'ballast' technology provides illumination of sufficient light level quality with reliable maintainability.

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[3] Railroad Accident Report—*Collision and Derailment of Maryland Rail Commuter* MARC *Train 286 and National Railroad Passenger Corporation* Amtrak *Train 29 Near Silver Spring, Maryland, on February 16, 1996* (NTSB/RAR-97/02).

At a meeting in December 1997, the FRA delegated this issue to its Railroad Safety Advisory Committee for Passenger Equipment Safety Standards Working Group and stated that this group will aggressively pursue this option for more reliable emergency illumination. The status of Safety Recommendation R-97-17 is "Open—Response Received."

The Safety Board concluded that passenger car interiors must have interior emergency lighting because a sufficient quantity of light sticks may not always be available, and light sticks may not be suitable for a large-scale evacuation such as the one that occurred in this accident. In addition, while the light stick may serve adequately as a personal emergency light source during an evacuation, it is not a self-contained emergency lighting source. Therefore, the Safety Board reiterated Safety Recommendation R-97-17 to the FRA.

The Kingman derailment also raised issues concerning seat securement. Inspection of train 4's seats indicated that none had become separated from their floor mountings. However, 18 seat assemblies were found with their rotating locking mechanisms not engaged. A disengaged seat lock can result in an uncontrolled rotation of the seat assembly, even in cases of a minor derailment, which may result in serious injuries to passengers. In the August 23, 1990, Batavia, Iowa,[4] accident report, the Safety Board stated its concern regarding Amtrak's seat locks and noted that seats can become unlocked either because the locking mechanisms are disengaged en route by passengers or because they are defective. The Safety Board issued the following safety recommendation to Amtrak:

R-91-71

> Implement procedures for on-board-service personnel to periodically check passenger seats en route for unlocked anti-rotational devices and take action to ensure seats are functional.

On May 22, 1992, this safety recommendation was classified "Closed—Acceptable Action," based on Amtrak's response that it was immediately issuing instructions systemwide to check and ensure that seat locks are functional and engaged.

Absolute assurance is not always possible, however, because passengers can readily disengage the mechanism to rotate the seat to suit their personal requirements and may fail to ensure that the locking mechanism is again positively engaged. Further, on-board service personnel may not be able to provide the constant vigilance necessary to ensure that the seat locking mechanisms have been properly restored, because the seat locking mechanism is not readily visible. The Safety Board concluded that the current procedures used to check and ensure that passenger car seat locks are functional and engaged are inadequate. A simple solution may be to employ a positive locking mechanism that requires use of a special keying feature accessible only to crewmembers (such as a conductor's coach key). This procedure could provide for seat locking security and effectively eliminate manipulation by passengers.

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[4] Railroad Accident Report—*Derailment of Amtrak Train No. 6 on the Burlington Northern Railroad, Batavia, Iowa, April 23, 1990* (NTSB/RAR-91/05).

Finally, the Safety Board's investigation of the Kingman accident indicated that improvements could be made in the use of locomotive event recorders. The problem of mismatched software readout programs being used to read event recorder information is not new to the Safety Board. Hundreds of software readout programs and versions of those programs are used to read out today's solid-state event recorders. The Safety Board laboratory is constantly updating its readout programs to keep current with the many programs and software revisions as they evolve. Unlike magnetic tape recorders, solid-state event recorders can only be read out using a computer and appropriate software. Therefore, it is imperative that event recorder data be read out using the correct software, to ensure that all the recorded data are extracted and that the data are accurate.

In this particular accident, however, Amtrak did not have the capability to read out all the data on its own recorders. Amtrak was unaware that valuable additional data had been recorded on its event recorders; six more parameters were actually recorded but not extracted by the Amtrak Integrated Function Computer analysis program. These parameters provide data about the operational characteristics of the train important for performing an accurate accident investigation. The Safety Board therefore concluded that, had Amtrak been more familiar with the specifications of the event recorders on train 4, it could have obtained additional information from them that would have been useful.

The FRA, in conjunction with the railroads and recorder/software manufacturers, is responsible for ensuring that all recorded data can be accurately and reliably retrieved after any train accident. No industry-wide procedures or Federal regulations address documentation of locomotive event recorders or readout system specifications. These specifications are necessary to conduct accurate readouts of event recorders. Physical inspections of the locomotive to determine the recording system specifications can be impractical or, in the case of severe accidents, impossible, because of component damage.

Therefore, event recorder system specifications should be kept as part of the locomotive's records. These records should be readily accessible for FRA or Safety Board inspection and must be kept up to date. These records should include, at a minimum: (1) the name, version, and date of the readout program intended for use with the recorder currently installed on the locomotive; (2) the manufacturer, model number, and serial number of the event recording device and its associated components (to include the air brake manifold, axle generator or equivalent, and signal conditioning devices) currently installed on the locomotive; (3) a complete list of parameters that the recording system is currently configured to record; and, (4) the recording system's manufacturer-prescribed modification, revision, and software-hardware version numbers.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Federal Railroad Administration:

> Require that all railroads identify and perform a one-time risk assessment of the bridges on their systems that have shallow foundations of similar construction to the bridge 504.1 that failed in the Kingman, Arizona, accident, and require replacement of those bridges determined to be susceptible to undermining and loss of the supporting foundation structure. (R-98-54)

Incorporate the intent of Safety Advisory 97-1 into minimum safety standards for special inspection procedures for bridges that would be at risk during severe weather. (R-98-55)

Include in the passenger car safety standards a requirement for positive seat securement systems to provide against the disengagement and undesired rotation of seats in all new passenger cars purchased after January 1, 2000, and require the incorporation of such a system into existing passenger cars when they are scheduled for overhaul. (R-98-56)

Require that event recorder system specifications be kept as part of the locomotive's records. (R-98-57)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

Please refer to Safety Recommendations R-98-54 through -57 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Jim Hall

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-58 through -61

Mr. George D. Warrington
Acting President
National Railroad Passenger Corporation
60 Massachusetts Avenue, N.E.
Washington, D.C. 20002

About 5:56 a.m., on August 9, 1997, Amtrak train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

The Safety Board identified several concerns as a result of its investigation, including the injuries to passengers of the Amtrak train. The investigation examined passenger safety and emergency response procedures, in addition to other issues.

The Safety Board investigated Amtrak's passenger and crew accounting procedures. During the emergency response to the Kingman accident, the Incident Commander requested a

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

copy of the train 4 manifest from an Amtrak employee. The conductor told Safety Board investigators that a passenger manifest was located in the dormitory car, but he did not have time to obtain it because he was helping passengers. The chief of on-board services said that he gave a copy of a sleeping car manifest to a firefighter. It took several days for Amtrak to provide an accurate passenger count of the entire train.

A complete manifest is necessary, in addition to the counts provided by the conductor, so that emergency responders will be able to locate people on the train as quickly as possible and be alerted about those people who may need immediate assistance because of injuries or disabilities. Although a complete manifest of train 4 was eventually available, infants and small children were not included on it because Amtrak does not require tickets for infants and small children. Because the survival of passengers or crewmembers could depend on their timely rescue by emergency responders, the complete manifest should be provided to the Incident Commander as soon as he arrives on scene. Although no complete manifest was available during the emergency response in this instance, the lack of one did not appear to negatively affect the efficiency of the emergency response.

As a result of the Safety Board's investigation into the Amtrak train accident in Mobile, Alabama,[2] the following safety recommendation was issued to Amtrak on September 30, 1994:

<u>R-94-7</u>

> Develop and implement procedures to provide adequate passenger and crew lists to local authorities with minimum delay in emergencies.

Amtrak responded to the safety recommendation on July 18, 1995, stating that a three-phase project to provide a satellite and messaging system between long-distance trains and the corporate entities associated with their operation would be implemented. According to Amtrak, phase I would install the system, phase II would expand the system to more trains, and phase III would provide nationwide voice communications. In a letter dated October 4, 1995, the Safety Board stated that it was pleased to learn that Amtrak was about to implement this project to provide satellite communications capability on trains and that the new system would provide more accurate passenger manifests. Pending implementation of the new system, the Board classified the safety recommendation "Open—Acceptable Response."

On October 19, 1997, an Amtrak official provided the Safety Board with an update of Amtrak's progress in developing the satellite system. The official stated that it would be difficult to account for passengers on Amtrak's unreserved trains because of the frequent stops such trains make. He compared the unreserved trains to transit systems. However, he said that a procedure to account for passengers on reserved Amtrak trains is possible, and that Amtrak has a computer system in place that could do it.

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[2]Railroad Accident Report—*Derailment of Amtrak Train No. 2 on the CSXT Big Bayou Canot Bridge Near Mobile, Alabama, September 22, 1993* (NTSB/RAR-94/01).

The Safety Board recognizes the practical limitations concerning Amtrak's providing a manifest on unreserved trains because those trains are frequently commuter trains on which passengers may board and detrain quickly, purchase tickets ranging from a per ride to a monthly basis, and not be confined to certain cars or seating. However, reserved trains do not have these characteristics and the procedure currently used to account for reserved train passengers, by counting tickets, can be improved. The Safety Board is aware that Amtrak has taken steps to improve its means of communication and ability to account for all occupants on board its reserved trains, and the Safety Board is encouraged by Amtrak's progress in this area.

Nevertheless, the Safety Board concluded that because an accurate passenger manifest was not provided by the Amtrak train 4 crew to the Incident Commander, the emergency response to evacuate and account for all passengers from the train could have been delayed, thus endangering passengers whose locations or circumstances were unknown to emergency responders. The Safety Board reclassified Safety Recommendation R-94-7 to Amtrak "Closed—Reconsidered."

The Safety Board also found problems concerning the adequacy of emergency training provided to Amtrak train 4 employees. Even though passengers were safely evacuated from the train, statements from the on-board service personnel and a review of their training records indicated that the reactions of several of them were based on instinct rather than organized emergency training. For example, one Amtrak attendant stated, "We had no real instruction or direction. We all went on instinct to help one another to see if there were injuries." He also stated that they needed more emergency training. Another train attendant had attended Amtrak's P.R.E.P.A.R.E. training course, which she said made her feel more "Knowledgeable, prepared, and focused on what needed to be done." This attendant recommended that all Amtrak crewmembers take the P.R.E.P.A.R.E. course on at least a 2-year cycle.

The Safety Board reviewed Amtrak's emergency situation training records for the 18 on-board service persons and operating crewmembers involved in this accident. The training time intervals recorded varied between employees. The most recent training that could be identified within the employee records ranged from training taken 2 months before the accident to training taken as much as 7 years before the accident. Eight employees did not have any emergency situation training dates listed in their training records. These findings are inconsistent with Amtrak's stated policy of scheduling emergency situation training at least every 3 years for on-board service attendants. Also, although the operating crew participated in refresher or recertification training, their training records indicate that the operating crew did not participate in emergency situation training with on-board service attendants.

Train 4's on-board service personnel did not use the public address system to communicate evacuation information to the passengers. Although some crewmembers believed that the public address system did not work, they did not attempt to use it even though Amtrak's emergency training procedures, as provided in the Amtrak training manual, call for its use in emergency situations. (Wreckage documentation showed that the public address system was inoperable in some of the cars because of the damage sustained by the equipment.)

During emergency situations, particularly those involving passenger evacuations, the train crew and on-board service personnel are responsible for managing and directing the safe evacuation of passengers. Passengers rely on the training, experience, and leadership of the on-board service personnel. Required periodic emergency situation training should prepare the train crewmembers to confidently perform their duties when emergency situations occur.

Since 1984, the Safety Board has addressed the need for Amtrak to improve its emergency situation training program. Over the years, the Safety Board has recognized improvements in Amtrak's training program. Following its investigation of the Amtrak train accident in Lugoff, South Carolina, on July 31, 1991,[3] the Safety Board recommended that Amtrak:

R-93-23

Require that all on-board service personnel periodically take training in emergency operating rules and first aid, cardiopulmonary resuscitation, and the use of the public address system during train emergencies.

In a letter dated December 27, 1993, Amtrak concurred with the merit of this recommendation. Amtrak formed a committee to develop an appropriate program to address these issues. The Safety Board responded on February 10, 1994, that a meeting with Amtrak would be postponed until the committee began its review of the issues. As a result, the Safety Board classified Safety Recommendation R-93-23 "Open—Acceptable Response."

Based on the personnel training record data reviewed in this accident, however, not all Amtrak employees appear to have received the necessary training or retraining in accordance with Amtrak's program. All employees should be provided the same level of emergency situation training within a reasonable time period. Although the evacuation went well in this accident, the responsibilities of train crewmembers should not be carried out in an ad hoc manner. Amtrak employees should be trained in their emergency responsibilities and not have to rely on instinct alone.

The lack of communication between the conductor and on-board service chief in providing a complete passenger manifest to the Incident Commander demonstrates a need for additional training of Amtrak personnel to emphasize their responsibilities when receiving requests from emergency responders and coordinating the emergency response on scene. In the Safety Board's investigation of an accident that occurred on February 16, 1996, near Silver Spring, Maryland,[4] the importance of the timely exchange of information between train crew personnel and the Incident Commander was examined. Coincident with the accident investigation, the Federal Railroad Administration (FRA) published, on February 24, 1997, the Notice of Proposed Rulemaking for *Passenger Train Emergency Preparedness*, which proposed requiring minimum Federal safety standards for the preparation, adoption, and implementation of emergency

[3] Railroad Accident Report—*Derailment and Subsequent Collision of Amtrak Train 82 With Rail Cars on Dupont Siding of CSX Transportation, Inc., at Lugoff, South Carolina, on July 31, 1991* (NTSB/RAR-93/02).

[4] Railroad Accident Report—*Collision and Derailment of Maryland Rail Commuter* MARC *Train 286 and National Railroad Passenger Corporation* Amtrak *Train 29 Near Silver Spring, Maryland, on February 16, 1996* (NTSB/RAR-97/02).

preparedness plans by railroads connected with the operation of passenger trains, including freight railroads hosting the operations of rail passenger service. The rule also required each affected railroad to instruct its employees about the provisions of the plan. The FRA issued the final rule on *Passenger Train Emergency Preparedness* on May 4, 1998, with an effective date of July 6, 1998.

The Safety Board concluded that Amtrak's current system for providing emergency training for train crews and on-board service personnel has not been effective, which has resulted in personnel being provided differing levels of emergency situation training.

The Safety Board also investigated how Amtrak train 4's emergency lighting and public address systems were affected by the derailment. The failure of emergency electrical systems to provide emergency power can be a serious problem in critical situations such as derailments. The emergency electrical system for each passenger car on train 4 was either at minimal output or at no power as a result of the derailment. Extensive undercarriage damage resulted in severed wiring and electrical conduits. Consequently, neither the interior emergency lights nor the public address system was reliable for operation, and no back-up system was provided. Passengers either had to rely on the instructions they were given by the Amtrak personnel in their car or to evacuate the train on their own.

Following a June 15, 1982, derailment of an Amtrak train in Emerson, Iowa,[5] the Safety Board issued the following safety recommendation to Amtrak:

> R-83-25
>
> Evaluate and modify, as necessary, emergency lighting systems in passenger-carrying cars to better protect the functioning of emergency lights in emergency situations.

Amtrak responded in 1984 that the emergency lighting system was designed to provide a minimum of 2 hours of acceptable illumination when the primary power source was interrupted. Amtrak believed that this 2-hour period was a reasonable length of time in an emergency situation. Amtrak also stated that using the existing commercial, battery-operated, self-contained fixtures on railway cars is not feasible. The safety recommendation was classified "Closed—Unacceptable Action" in April 1988.

On September 22, 1993, Amtrak train 2 derailed into the Big Bayou Canot near Mobile, Alabama,[6] at about 2:53 a.m. Forty-two passengers and 5 crewmembers were killed; 103 passengers were injured. The Safety Board issued the following safety recommendation to Amtrak:

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[5] Railroad Accident Report—*Derailment of Amtrak Train No. 5 (the San Francisco Zephyr) on the Burlington Northern Railroad, Emerson, Iowa, June 15, 1982* (NTSB/RAR-83/02).

[6] NTSB/RAR-94/01.

R-94-8

Equip cars with portable lighting for use by passengers in an emergency.

In July 1995, Amtrak stated that it was evaluating the use of portable chemical light sticks for permanent installation on all Amtrak trains. Such light sticks are weatherproof, maintenance-free, nontoxic, nonflammable, and not sources of ignition. They provide immediate and dependable light for up to 8 hours. Amtrak placed light sticks on all its passenger trains, and Safety Recommendation R-94-8 was classified "Open—Acceptable Action."

In the Kingman accident, the Amtrak light sticks provided sufficient emergency lighting until the arrival of emergency responders. Light stick use was limited, but the usefulness of the light sticks was well acknowledged by the passengers, and they provided a measure of safety when the emergency lighting failed. Based on these actions by Amtrak, the Safety Board classified Safety Recommendation R-94-8 "Closed—Acceptable Action" on March 26, 1998.

The Safety Board is, however, concerned that not enough is being done to provide for passenger safety when emergency power is lost. In the 1996 Silver Spring accident,[7] a contributing factor to the severity of the accident and the loss of life was the lack of appropriate regulations to ensure adequate emergency egress features on railroad passenger cars. The Safety Board concluded that passenger car interiors must have interior emergency lighting because a sufficient quantity of light sticks may not always be available, and light sticks may not be suitable for a large-scale evacuation such as the one that occurred in this accident. In addition, while the light stick may serve adequately as a personal emergency light source during an evacuation, it is not a self-contained emergency lighting source.

The Kingman derailment also raised issues concerning seat securement. Inspection of train 4's seats indicated that none had become separated from their floor mountings. However, 18 seat assemblies were found with their rotating locking mechanisms not engaged. A disengaged seat lock can result in an uncontrolled rotation of the seat assembly, even in cases of a minor derailment, which may result in serious injuries to passengers. In the August 23, 1990, Batavia, Iowa,[8] accident report, the Safety Board stated its concern regarding Amtrak's seat locks and noted that seats can become unlocked either because the locking mechanisms are disengaged en route by passengers or because they are defective. The Safety Board issued the following safety recommendation to Amtrak:

R-91-71

Implement procedures for on-board-service personnel to periodically check passenger seats en route for unlocked anti-rotational devices and take action to ensure seats are functional.

[7]NTSB/RAR-97/02.

[8]Railroad Accident Report—*Derailment of Amtrak Train No. 6 on the Burlington Northern Railroad, Batavia, Iowa, April 23, 1990* (NTSB/RAR-91/05).

On May 22, 1992, this safety recommendation was classified "Closed—Acceptable Action," based on Amtrak's response that it was immediately issuing instructions systemwide to check and ensure that seat locks are functional and engaged.

Absolute assurance is not always possible, however, because passengers can readily disengage the mechanism to rotate the seat to suit their personal requirements and may fail to ensure that the locking mechanism is again positively engaged. Further, on-board service personnel may not be able to provide the constant vigilance necessary to ensure that the seat locking mechanisms have been properly restored, because the seat locking mechanism is not readily visible. The Safety Board concluded that the current procedures used to check and ensure that passenger car seat locks are functional and engaged are inadequate. A simple solution may be to employ a positive locking mechanism that requires use of a special keying feature accessible only to crewmembers (such as a conductor's coach key). This procedure could provide for seat locking security and effectively eliminate manipulation by passengers.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the National Railroad Passenger Corporation:

> Expedite the development and implementation of a passenger and crew accountability system on reserved trains. (R-98-58)
>
> Implement effective controls to monitor and ensure that all train crews and on-board service personnel receive the necessary initial and recurrent emergency training to provide for passenger safety. (R-98-59)
>
> Install, in all new passenger equipment purchased after January 1, 2000, and in existing passenger cars during their major overhaul/rebuild operations, fixtures that use a "self-contained back-up energy reserve feature" to make the fixtures less vulnerable to the disruption of electrical power during derailments. (R-98-60)
>
> Install a positive seat securement system to prevent disengagement and undesired rotation in all new passenger cars purchased after January 1, 2000, and incorporate such a system into existing passenger cars when they are scheduled for overhaul. (R-98-61)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations.

Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-98-58 through -61 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply to refer to: R-98-62

Sheriff Tom Sheahan
Mohave County Sheriff's Department
301 West Beale Street
Post Office Box 1191
Kingman, Arizona 86402

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

The Safety Board is concerned that unverified notification information was issued during the emergency response to this accident. During the initial communication of on-site information by local agencies, some confusion resulted in the erroneous reporting of 8 to 13 fatalities, when no fatalities had actually occurred. A BNSF special agent called the Mohave County Sheriff's Department to inquire about the accident and was told that two persons in the upper level of train

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

4's dormitory car were seriously injured and that those injured would probably be "DOA." The BNSF relayed this information to other BNSF employees and, in some cases, stated that two DOAs were reported. In subsequent conversations with the Mohave dispatcher and a sergeant, the BNSF special agent overheard the dispatcher talking to someone on scene over the radio referring to "six downstairs." The special agent asked if she had heard that there were two DOAs upstairs and six DOAs downstairs in the dormitory car; the sergeant replied, "Yes." The initial speculation by the Mohave dispatcher that those persons with serious injuries would become DOAs apparently caused others to use that same terminology. This incorrect information was subsequently relayed to various, including Federal, organizations.

The Safety Board recognizes that conflicting reports of the circumstances of an accident often are communicated initially, and that in the early stages of the response, emergency responders must speculate and evaluate the situation to ensure that adequate resources are available for the worst-case scenario; but speculation is not fact. The information that is relayed to responding agencies must be as accurate as possible, and information that is relayed to other parties must either be confirmed as factual or clearly characterized as unverified. The Safety Board concluded that the inaccurate reporting of fatalities that took place during the accident notification process was a result of unconfirmed information being relayed to Federal agencies by local organizations.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Mohave County Sheriff's Department:

> Review the circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997, with your dispatchers and emphasize the importance of relaying verified factual information when communicating with other agencies. (R-98-62)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-62 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Jim Hall

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-63

Mr. Daniel N. Rosenblatt
Executive Director
International Association of Chiefs of Police
515 N. Washington Street
Alexandria, Virginia 22314-2357

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

The Safety Board is concerned that unverified notification information was issued during the emergency response to this accident. During the initial communication of on-site information by local agencies, some confusion resulted in the erroneous reporting of 8 to 13 fatalities, when no fatalities had actually occurred. A BNSF special agent called the Mohave County Sheriff's

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

Department to inquire about the accident and was told that two persons in the upper level of train 4's dormitory car were seriously injured and that those injured would probably be "DOA." The BNSF relayed this information to other BNSF employees and, in some cases, stated that two DOAs were reported. In subsequent conversations with the Mohave dispatcher and a sergeant, the BNSF special agent overheard the dispatcher talking to someone on scene over the radio referring to "six downstairs." The special agent asked if she had heard that there were two DOAs upstairs and six DOAs downstairs in the dormitory car; the sergeant replied, "Yes." The initial speculation by the Mohave dispatcher that those persons with serious injuries would become DOAs apparently caused others to use that same terminology. This incorrect information was subsequently relayed to various, including Federal, organizations.

The Safety Board recognizes that conflicting reports of the circumstances of an accident often are communicated initially, and that in the early stages of the response, emergency responders must speculate and evaluate the situation to ensure that adequate resources are available for the worst-case scenario; but speculation is not fact. The information that is relayed to responding agencies must be as accurate as possible, and information that is relayed to other parties must either be confirmed as factual or clearly characterized as unverified. The Safety Board concluded that the inaccurate reporting of fatalities that took place during the accident notification process was a result of unconfirmed information being relayed to Federal agencies by local organizations.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the International Association of Chiefs of Police:

> Review the circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997, with your dispatchers and emphasize the importance of relaying verified factual information when communicating with other agencies. (R-98-63)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-64 to the National Sheriffs' Association, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-63 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-64

Mr. Aldine N. Moser, Jr.
Executive Director
National Sheriffs' Association
1450 Duke Street
Alexandria, Virginia 22314

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

The Safety Board is concerned that unverified notification information was issued during the emergency response to this accident. During the initial communication of on-site information by local agencies, some confusion resulted in the erroneous reporting of 8 to 13 fatalities, when no fatalities had actually occurred. A BNSF special agent called the Mohave County Sheriff's

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

Department to inquire about the accident and was told that two persons in the upper level of train 4's dormitory car were seriously injured and that those injured would probably be "DOA." The BNSF relayed this information to other BNSF employees and, in some cases, stated that two DOAs were reported. In subsequent conversations with the Mohave dispatcher and a sergeant, the BNSF special agent overheard the dispatcher talking to someone on scene over the radio referring to "six downstairs." The special agent asked if she had heard that there were two DOAs upstairs and six DOAs downstairs in the dormitory car; the sergeant replied, "Yes." The initial speculation by the Mohave dispatcher that those persons with serious injuries would become DOAs apparently caused others to use that same terminology. This incorrect information was subsequently relayed to various, including Federal, organizations.

The Safety Board recognizes that conflicting reports of the circumstances of an accident often are communicated initially, and that in the early stages of the response, emergency responders must speculate and evaluate the situation to ensure that adequate resources are available for the worst-case scenario; but speculation is not fact. The information that is relayed to responding agencies must be as accurate as possible, and information that is relayed to other parties must either be confirmed as factual or clearly characterized as unverified. The Safety Board concluded that the inaccurate reporting of fatalities that took place during the accident notification process was a result of unconfirmed information being relayed to Federal agencies by local organizations.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the National Sheriffs' Association:

> Review the circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997, with your dispatchers and emphasize the importance of relaying verified factual information when communicating with other agencies. (R-98-64)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-65 to the Association of American Railroads, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-64 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply refer to: R-98-65

Mr. Edward R. Hamberger
President
Association of American Railroads
50 F Street, N.W.
Washington, D.C. 20001

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

During the investigation, the Safety Board considered the circumstances that precipitated the bridge failure. The investigation examined the adequacy of the design, maintenance,

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

inspection, and drainage area characteristics of BNSF bridge 504.1[2] in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a crosswall and the bridge supporting structure.

Bridge 504.1 S was supported by a shallow foundation consisting of timber mud sills and timber blocking. BNSF records showed that the bridge supports were susceptible to scouring and erosion as early as 1959, when it was necessary to add stones and grout to a portion of the streambed. In the succeeding years, additional stones and grouting were added. Records also showed that, in 1975, maintenance personnel were still concerned about the bridge supporting structure and its water-carrying capacity. In fact, they remained so concerned that they recommended that the bridge be placed on the Capital Improvement Program (CIP) list for replacement.

Also, BNSF bridge records identifying the size of the drainage area for bridge 504.1 (the north and south bridge spans) were inconsistent. One record showed the drainage area as encompassing 3.8 square miles, while another showed the drainage area as totaling 19.09 square miles. The size of the drainage area is an important element in determining the required waterway opening for drainage structures. After the accident, a BNSF consultant (HDR Engineering, Inc.) determined that the drainage area for bridge 504.1 was 19.5 square miles. The consultant's report cited the accepted engineering practice of using the 100-year storm criteria to provide for drainage structures but noted that local conditions and circumstances, such as the desert nature of the Kingman area, allowed for making an engineering judgment resulting in higher or lower values. According to the consultant's report, the bridges located at MP 504.1 at the time of the accident were capable of withstanding a 24-year storm. The storm related to this accident was determined to have been approaching a 50-year storm event of 2 hours' duration. (The August 9, 1997, storm's effect differed among the five railroad bridges in the area. Bridge 504.1 experienced an approximate 50-year storm event, while bridge 503.7, for example, experienced an approximate 10-year storm event.)

In 1975, the railroad management placed bridge 504.1 on the 1977 CIP replacement program because the results of engineering studies raised concerns about the bridge's ability to provide an adequate waterway opening and about recurring erosion problems. In early 1976, however, the railroad's bridge maintenance personnel made a field decision to build an unreinforced concrete crosswall on the downstream side of bridge 504.1. Bridge 504.1 was subsequently removed from the 1977 replacement program.

Only two instances of high water were recorded for bridge 504.1 and both took place in 1976. This was after 1971 work affecting the box culverts downstream from the BNSF bridges had been performed by the Arizona Department of Transportation and after bridge 504.1 had been removed from the CIP budget list. Before the 1997 derailment at bridge 504.1S, no accidents involving high water or bridge failure were recorded for the Kingman area.

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[2] The BNSF designates bridges by their milepost (MP) numbers. There are two separate bridges at MP 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

The purpose of the unreinforced concrete crosswall was to allow silt to back up and accumulate around the mud sills, thus acting to mitigate further scouring and erosion. However, no engineering evaluation was performed on the design and construction of the unreinforced concrete crosswall to determine the necessary anchorage, the appropriate size, the need for reinforcement, or the hydrologic characteristics of the waterway.

The severe flash flooding and resultant stream flow between bridge 504.1 and Arizona State Route 66 caused severe erosion that rapidly progressed upstream. The Safety Board could not determine whether channel improvements made in 1971 contributed to this development, but evidence of streambed erosion was found during the on-site investigation. This erosion progression caused the failure of the unreinforced concrete crosswall because it was not anchored and was only 33 inches in depth. Because it was unreinforced, the crosswall broke into several pieces when its shallow footing was undermined.

When the concrete crosswall failed, the rate of erosion accelerated through the accumulated silt to the point that it quickly progressed to the shallow foundation of the bridge. This process undermined the bridge's mud sills and timber blocking and compromised the bridge's ability to support Amtrak train 4. The Safety Board therefore concluded that the failure of the bridge 504.1S was caused by scour and erosion affecting the inadequately protected shallow foundations that supported the bridge; the scour resulted because a poorly designed concrete crosswall was built instead of a new and better-engineered bridge. The Safety Board is concerned that similar situations may exist on other railroad systems in the country that are subject to flash flooding.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Association of American Railroads:

> Make your membership aware of the facts and circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997. (R-98-65)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, and R-98-66 to the American Short Line and Regional Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-65 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 16, 1998

In reply to refer to: R-98-66

Mr. William E. Loftus
President
American Short Line and Regional
Railroad Association
1120 G Street, N.W.
Suite 520
Washington, D.C. 20005-3889

About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a "hump" in the track as they approached bridge 504.1S. They applied the train's emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge's supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately $7.2 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

During the investigation, the Safety Board considered the circumstances that precipitated the bridge failure. The investigation examined the adequacy of the design, maintenance,

[1]For more detailed information, read Railroad Accident Report—*Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

inspection, and drainage area characteristics of BNSF bridge 504.1[2] in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a crosswall and the bridge supporting structure.

Bridge 504.1 S was supported by a shallow foundation consisting of timber mud sills and timber blocking. BNSF records showed that the bridge supports were susceptible to scouring and erosion as early as 1959, when it was necessary to add stones and grout to a portion of the streambed. In the succeeding years, additional stones and grouting were added. Records also showed that, in 1975, maintenance personnel were still concerned about the bridge supporting structure and its water-carrying capacity. In fact, they remained so concerned that they recommended that the bridge be placed on the Capital Improvement Program (CIP) list for replacement.

Also, BNSF bridge records identifying the size of the drainage area for bridge 504.1 (the north and south bridge spans) were inconsistent. One record showed the drainage area as encompassing 3.8 square miles, while another showed the drainage area as totaling 19.09 square miles. The size of the drainage area is an important element in determining the required waterway opening for drainage structures. After the accident, a BNSF consultant (HDR Engineering, Inc.) determined that the drainage area for bridge 504.1 was 19.5 square miles. The consultant's report cited the accepted engineering practice of using the 100-year storm criteria to provide for drainage structures but noted that local conditions and circumstances, such as the desert nature of the Kingman area, allowed for making an engineering judgment resulting in higher or lower values. According to the consultant's report, the bridges located at MP 504.1 at the time of the accident were capable of withstanding a 24-year storm. The storm related to this accident was determined to have been approaching a 50-year storm event of 2 hours' duration. (The August 9, 1997, storm's effect differed among the five railroad bridges in the area. Bridge 504.1 experienced an approximate 50-year storm event, while bridge 503.7, for example, experienced an approximate 10-year storm event.)

In 1975, the railroad management placed bridge 504.1 on the 1977 CIP replacement program because the results of engineering studies raised concerns about the bridge's ability to provide an adequate waterway opening and about recurring erosion problems. In early 1976, however, the railroad's bridge maintenance personnel made a field decision to build an unreinforced concrete crosswall on the downstream side of bridge 504.1. Bridge 504.1 was subsequently removed from the 1977 replacement program.

Only two instances of high water were recorded for bridge 504.1 and both took place in 1976. This was after 1971 work affecting the box culverts downstream from the BNSF bridges had been performed by the Arizona Department of Transportation and after bridge 504.1 had been removed from the CIP budget list. Before the 1997 derailment at bridge 504.1S, no accidents involving high water or bridge failure were recorded for the Kingman area.

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[2]The BNSF designates bridges by their milepost (MP) numbers. There are two separate bridges at MP 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

The purpose of the unreinforced concrete crosswall was to allow silt to back up and accumulate around the mud sills, thus acting to mitigate further scouring and erosion. However, no engineering evaluation was performed on the design and construction of the unreinforced concrete crosswall to determine the necessary anchorage, the appropriate size, the need for reinforcement, or the hydrologic characteristics of the waterway.

The severe flash flooding and resultant stream flow between bridge 504.1 and Arizona State Route 66 caused severe erosion that rapidly progressed upstream. The Safety Board could not determine whether channel improvements made in 1971 contributed to this development, but evidence of streambed erosion was found during the on-site investigation. This erosion progression caused the failure of the unreinforced concrete crosswall because it was not anchored and was only 33 inches in depth. Because it was unreinforced, the crosswall broke into several pieces when its shallow footing was undermined.

When the concrete crosswall failed, the rate of erosion accelerated through the accumulated silt to the point that it quickly progressed to the shallow foundation of the bridge. This process undermined the bridge's mud sills and timber blocking and compromised the bridge's ability to support Amtrak train 4. The Safety Board therefore concluded that the failure of the bridge 504.1S was caused by scour and erosion affecting the inadequately protected shallow foundations that supported the bridge; the scour resulted because a poorly designed concrete crosswall was built instead of a new and better-engineered bridge. The Safety Board is concerned that similar situations may exist on other railroad systems in the country that are subject to flash flooding.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the American Short Line and Regional Railroad Association:

> Make your membership aware of the facts and circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997. (R-98-66)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, and R-98-65 to the Association of American Railroads.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-66 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman